

The Paryphantidae of New Zealand: their Hypothetical Ancestry, with descriptions of New Species and a New Genus.

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Study of the distribution of land snails has long been recognised to be of great value in suggesting former land connections, for it is well known that immersion for a length of time in either fresh or salt water is sufficient to kill individuals or the life within their eggs. In the case of *Paryphanta* these eggs are of such large size that any suggestion of accidental transportation by means of migratory birds or other chance means need not be considered.

The inferences are that continuous land is necessary for dispersal and that the species must have developed approximately within or close to the areas they now occupy, and that geographic features such as mountain ranges, river systems and islands, have played and are still playing an important part in the segregation and evolution of species.

In this paper an attempt has been made, not only to record and describe species of the larger New Zealand land snails but to illustrate that many of the so termed colour variations are constant within definite geographic areas and for this reason alone are well worthy of subspecific distinction.

HOW PRESENT GEOGRAPHIC FEATURES GOVERN THE DISTRIBUTION OF SPECIES.

Typical *hochstetteri* and its subspecific forms live on the mountains at between 2,500 feet and the snow-line. They are very rarely found living below this level and never lower than 2,000 feet. This habit no doubt originated through climatic conditions, as it is essential to the life of *Paryphanta* to be kept continually moist, not being adapted to withstand long periods of dryness.

Possibly the present mountain habitat most closely corresponds to general weather conditions previously prevalent in this country. Whatever the cause, the mountain habit, whether recently acquired or not, is assisting even at the present time in the gradual evolution of new forms by isolation.

These mountain tops are as islands in a sea, the surrounding low country below the 2,000 ft. level acting as a barrier between the mountain areas.

This fact is well illustrated in comparing (a) the Western, and (b) the Eastern distribution of the *hochstetteri* forms.

(a) Taking the western area, that of the typical species, we have a continuous distribution over the high country of west Nelson; along the Pikikiruna Range, across the Tasman Range and then north again along the Haupiri Range.

All the specimens collected and examined from these connected mountain systems are characterized by a light base with the umbilical area free from bands or colour zone.

(b) The eastern or Marlborough Sounds area is a complex system of mountains, further complicated by comparatively recent subsidence, allowing great inroads by the sea. This whole area is now completely isolated so far as high country connections are concerned, being bounded by the sea to the north, the valley of the Wairau to the east, the Waimea Plain to the west and to the south by a low saddle near Tophouse, separating the St. Arnaud Range from the apparently nameless range continuing north to D'Urville and Stephen Islands.

The shells from this area belong to subspecific forms of *hochstetteri*, differing in having a basal colour patch invariably present, filling and surrounding the umbilical area. These can be further subdivided into two regional colour forms, a western type with the base almost entirely dark and an eastern type in which the dark colour is confined to a small patch in and around the umbilicus. The dividing line between these two forms however is imperfect, the areas of distribution overlapping, causing a few intermediate forms.

In west coast districts where there is a greater rainfall species of *Paryphanta* range down almost to sea level. In North-west Nelson the Whakamarama Range and western coastal strip supports the distinctive *gilliesi* and its subspecies *subfusca*, which latter is isolated from the typical species by the waters of West Haven Inlet.

Similarly further down the coast the axially striped *lignaria* is found from Karamea to the north side of the Mokihinui River, while a related species without colour bands is restricted to the area from the south side of the river to Westport. A further species of this series is described in this paper from the vicinity of Ross but its boundaries still need to be determined for only a single specimen has so far been found.

HYPOTHETICAL GEOLOGICAL ANCESTRY AND DEVELOPMENT.

A. (PARYPHANTA)

The fact that *Rhytida* and closely allied genera range from South Africa to New Caledonia while *Paryphanta* is probably restricted to New Zealand, Tasmania and Victoria points to greater antiquity and a more ancient dispersal for the former.

No doubt *Paryphanta* originated from *Rhytida* like stock within the New Zealand faunal area and achieved its greatest distribution during the great land extensions of the Lower Cretace-

ous whereby Tasmania and Victoria gained the ancestors of their present species. The route was probably via New Caledonia and Eastern Australia.

It has been pointed out that cool temperatures and moist conditions are essential to *Paryphanta* which does not possess the ability to conserve moisture by sealing the shell with an epiphragm. The genus has survived therefore only in locations where moist conditions have prevailed.

Species ascribed to *Paryphanta* are on record from both New Guinea and the Louisiades, but it is very doubtful if any of these belong to the family.

Unfortunately the writer has been unable to secure specimens or refer to the original description of the Louisiades species (*P. louisadarum* Moellendorff, Nachrbl. Deutsch. Malak. Ges. pp. 20-22, 1899.)

The New Guinea species were described by Fulton (Ann. Mag. Nat. Hist. vol. 9, seventh ser. p. 182, 1902). One of these, *elegans* has a carinated periphery with hair-like projections so can be excluded from the family. Fulton's other species, *striata*, which is closely allied to *louisadarum* according to its author, is also quite small having a maximum diameter of only 9 mm.

The small size of these species alone indicates that they probably do not belong to the genus *Paryphanta*. *

During the Lower Tertiary great land subsidence probably caused the drowning of the greater part of the *Paryphanta* distribution, isolating in the northern part of the North Island the ancestors of the living *busbyi*, to which the Victorian and Tasmanian species are probably nearest allied. Similarly a southern remnant of the older land developed the *hochstetteri* ancestors on what is now the northern part of the South Island.

In describing the later geological history of New Zealand, Dr. Cotton (1916, p. 248) wrote:—"The most profound deformation of this vast sedimentary group took place in the Jurassic or early Cretaceous times . . . when probably a great mountain range came into existence." . . . "From the above considerations and from a general survey of what is known of the Tertiary Rocks it is apparent that during the period of their deposition a great part of the site of the present islands of New Zealand was continuously submerged, and that very little of the remainder was left above water."

In a paper dealing with West Nelson Dr. J. Henderson (1911, p. 312) wrote:—"The land seems to have been above sea-level till Tertiary times, when depression permitted the inroads

* Since this was written J. Thiele in a paper entitled, "Mollusken vom Bismark-Archipel, von Neu-Guinea und Nachbar-Insel" (Zoologische Jahrbucher, Jena, 55, pp. 126-127, 1928), has proposed *Paryphantopsis*, a new subgenus of *Flammulina* for these shells, referring it to the *Endodontidae*. (= *Flammulinidae* of Iredale and *Endodontidae-Phenacohelicidae* of Suter.) Thiele's excellent figures of these shells show features quite foreign to the *Paryphantidae* and his description of both the nuclear and dental characters prove the relationship with the *Endodontidae*.

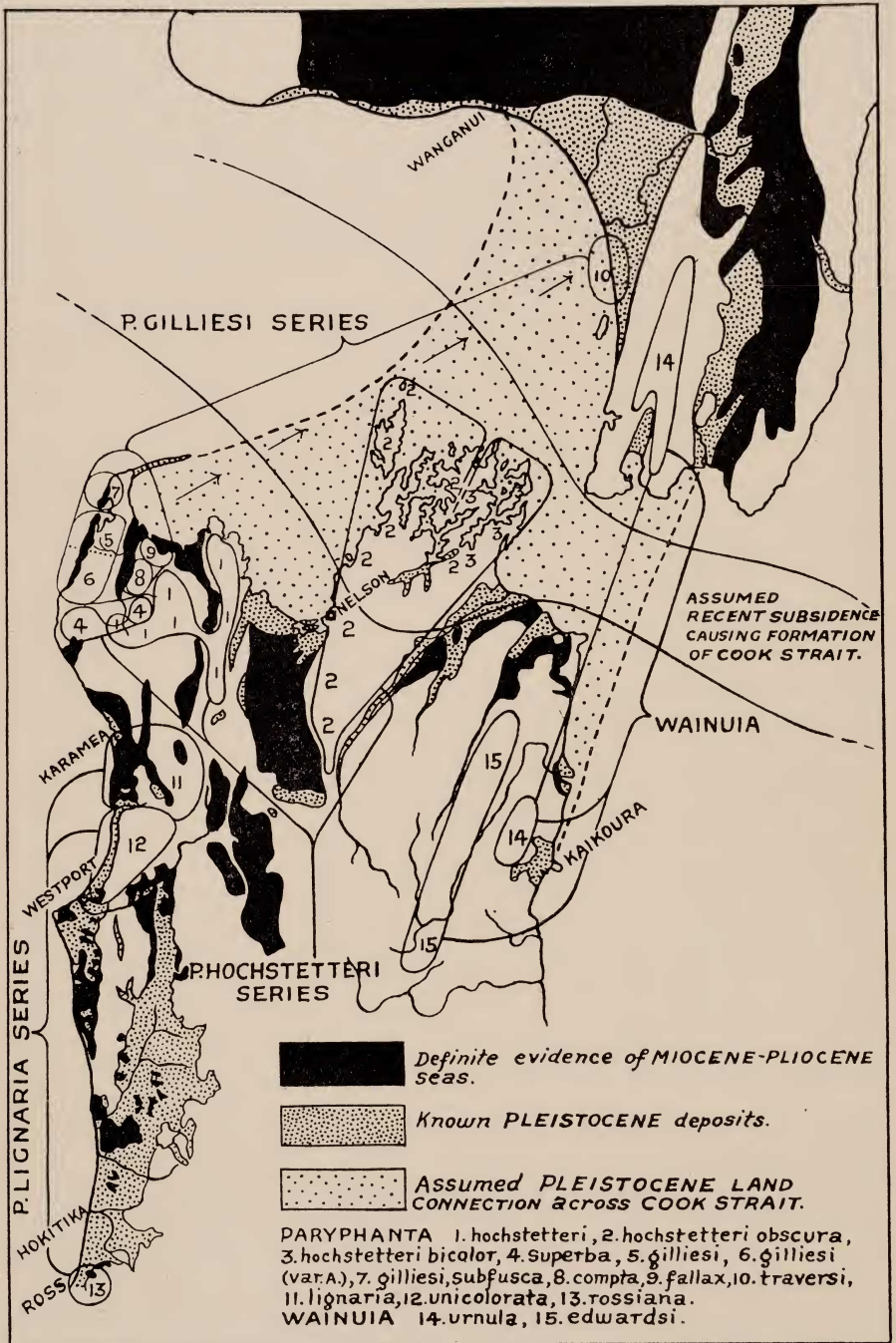


Fig. 1. HYPOTHETICAL GEOLOGICAL MAP OF THE COOK STRAIT REGION, ILLUSTRATING THE DISTRIBUTION OF PARYPHANTA AND WAINUIA.

(Based partly on Morgan's 1922 Geological Sketch Maps of N.Z.)

of the sea into rift-valleys which had already been formed." . . . "Further depression permitted the formation of sandstones. . . ." etc. "When these last were formed the land surface of what is now West Nelson was represented by a series of base-levelled islands."

Probably the small *Paryphantas* of the *gilliesi* series owe their origin to isolation on West Nelson island blocks that escaped submergence. Similar detached areas to the south were no doubt responsible for the development of such distinctive types as *lignaria* and *superba*.

It is well known that evolution by deviation from type is often accelerated as the result of small colonies becoming isolated.

Later came a period of great uplift which reached its maximum during Pliocene and Pleistocene times providing new land for colonization.

The Pleistocene was an age of great mountain building, glaciation, rapid weathering and the resultant formation of extensive plains. The great erosion that took place points to a very heavy rainfall, a condition favourable to the dispersal of *Paryphanta*.

So complete was the erosive work of the *Pleistocene* that in West Nelson practically the whole of the Goulard Downs area and most of the country on the eastern side of the Aorere was stripped of the Miocene covering strata.

A new species, *compta*, described in this paper from The Castles, a ridge of about 2,000 feet elevation situated on the eroded sloping plateau of the eastern side of the Aorere Valley, probably owes its origin to an eastern drift of the *gilliesi* type after the uplift of the present Aorere Valley floor. Old crushed specimens referable to this species occur in the Pleistocene and Recent silts of the valley, suggesting that *compta* once covered a much wider area but has been diminished together with the erosion of the land surface.

Another species of the *gilliesi* series occurs on the ridge running from behind Onekaka to Parapara Peak, on Palaeozoic rocks of the Aorere Series. Possibly this species owes its origin to insular isolation at the same time that the Whakamarama *gilliesi* ancestors were isolated.

The species from The Castles shows closer relationship to *gilliesi* than to the Onekaka species, they being the only two species of *Paryphanta* with a granulated parietal wall.

Geologists are of the opinion that during the Pliocene and until comparatively recent times Cook Strait was closed. Support to this idea is given by the occurrence of a *Paryphanta* related to the West Nelson *gilliesi* series, on the Pleistocene plains around Levin.

These plains have been practically stripped of their forest covering for agricultural purposes so it is now impossible to estimate the former extent of the colony.

This low country habit has no doubt been inherited from West Nelson ancestors of the *gilliesi* series, for the relationship as shown by shell proportions cannot be denied.

The final separation of the Levin species from its South Island relatives was due to the formation of Cook Strait, which feature is considered to be of very recent origin. Dr. Cotton (1916, p. 319) wrote:—"Faults of late date appear also to have determined the outlines of at least some parts of the New Zealand coast, especially in and about Cook Strait." And in a later paper (1918, p. 325): "This justifies the adoption of a tentative hypothesis that at the close of the orogenic movements which gave birth to the New Zealand land mass, the dividing strait was not in existence, and that the separation of the two islands has taken place subsequently, as a result of subsidence of blocks, possibly contemporaneous with the partial subsidence of an adjacent portion of the South Island."

B. (WAINUIA)

Probably contemporaneous with the evolution of the *Paryphanta* series a second genus here named *Wainuia* and showing affinity to both *Paryphanta* and *Rhytida* was developing on the Kaikoura-Tararua block.

Dr. Cotton (1916, p. 248) wrote:—"The orogenic movements which followed the Tertiary deposition, and to which the present relief is entirely or almost entirely due must have occurred in or about the Pliocene period. The period of movement may be termed the 'Kaikoura orogenic period' since the Kaikoura ranges were the first to be explained . . . as owing the whole of their elevation to these late earth-movements." And later (1922, p. 184): "The valleys of the Awatere and Wairau Rivers clearly mark the position of depressed blocks—great triangular areas of subsidence."

The Wairau and Awatere River Valleys now extend far inland and have probably existed since pre-Tertiary times, effectively separating the Kaikoura block and its land fauna from the Marlborough Sounds—Nelson area.

The distribution of the two species of *Wainuia* is satisfactorily explained by the assumed recent origin of Cook Strait. One of the species is apparently confined to the Inland Kaikoura system and Hossack Downs a mountain area to the south, but the other is found on both sides of Cook Strait, the Rimutaka-Tararua systems in the North and on the Seaward Kaikouras in the South Island.

C. (RHYTIDA)

As previously suggested *Rhytida* is considered the most ancient genus of the *Paryphantidae* in New Zealand. Species are distributed over the North, South and Stewart Islands. One species, *greenwoodi*, is found on both sides of Cook Strait and affords still further evidence of the comparatively recent origin of this geographic feature, which has evidently not been in existence sufficiently long to have caused a faunal division.

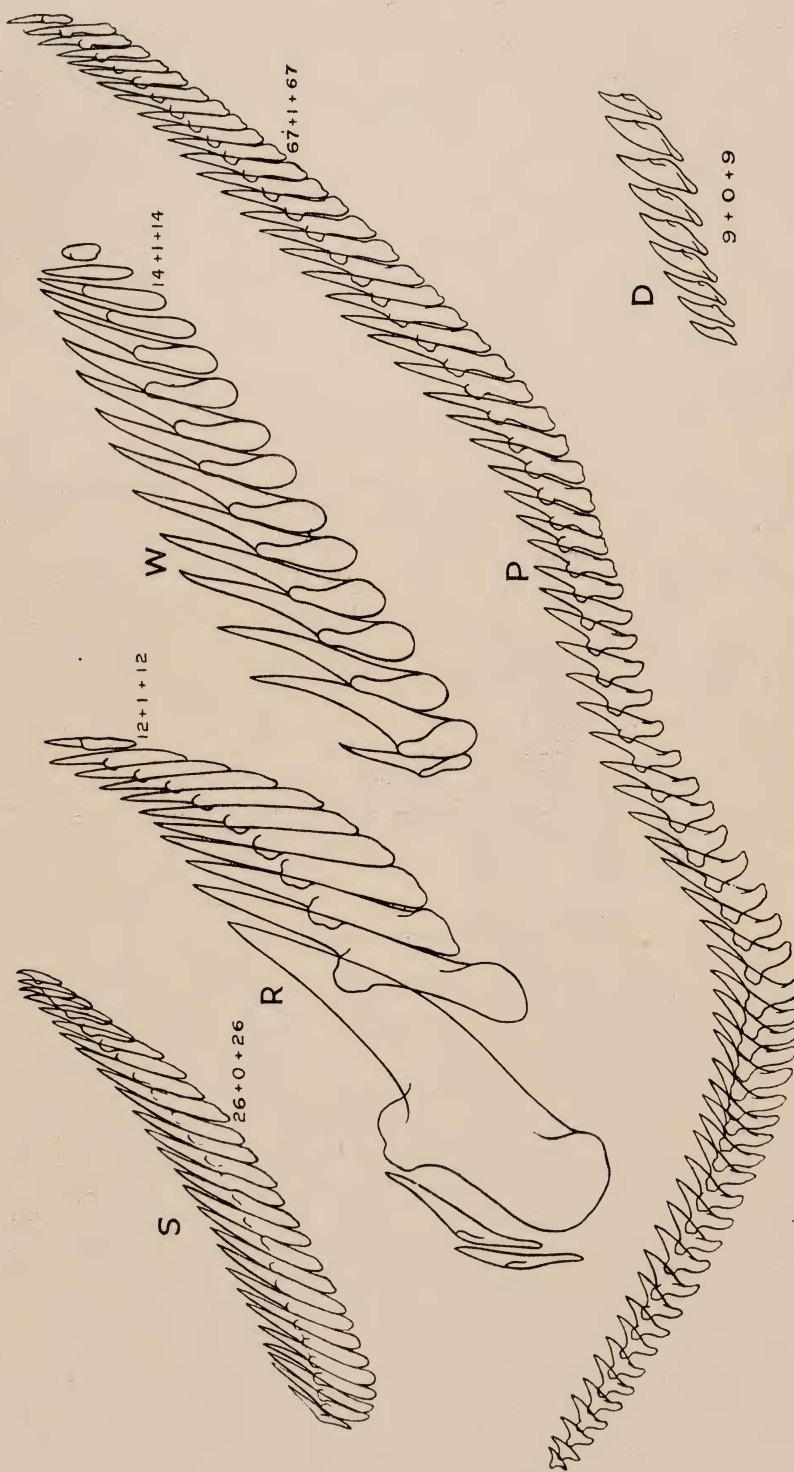


Fig. 2. GENERIC TYPES OF DENTITION IN PARYPHANTIDAE.
 S. *Schizoglossa* (Type), R. *Rhytida* (Type), W. *Wainuia* (Type),
 P. *Paryphanta* (*hochstetteri*), D. *Delos* (Type).

DENTITION.

The dentition presents a distinctive type for each of the five New Zealand genera. (Text Fig. 2.) Specific distinctions are also well shown in the genera *Rhytida* and *Wainuia*, but in some members of the *hochstetteri* and *gilliesi* series of the genus *Paryphanta* the radulae are all very similar, showing close relationship, and making the selection of a precise formula for each of the species impossible. Shell characters alone have been used in these species as they have proved quite constant and distinctive among each of the geographic or regional types.

Paryphanta has a radula consisting of a large number of aculeate laterals gradually increasing in size from the margin and then decreasing again towards the centre. Typical formula, $50 + 0 + 50$.

Rhytida has a radula consisting of a comparatively small number of aculeate laterals. Mostly with a few very small teeth at the margin followed by the largest tooth, then decreasing to the centre. Central tooth mostly present. Typical formula, $12 + 1 + 12$.

Wainuia has a radula consisting of a comparatively small number of aculeate laterals. First tooth at margin half the height of the next which is the largest, then decreasing to the centres. Central tooth small. Typical formula, $14 + 1 + 14$.

Schizoglossa has a radula consisting of a moderately large number of aculeate laterals. First tooth at margin small, following four rapidly increasing, then gradually decreasing to the centre. No central tooth. Typical formula, $26 + 0 + 26$.

Delos has a radula consisting of a very small number of aculeate laterals, increasing in size from the margin, last one smaller. No central tooth. Typical formula, $9 + 0 + 9$.

FOOD OF PARYPHANTA.

These snails feed on the common bush earth-worms. The writer has removed from a living specimen of *gilliesi* an entire worm eight and a half inches in length.

This worm had not been swallowed but simply enveloped in the folds of the foot and withdrawn into the shell until lifeless. Later, no doubt the worm would have been eaten at leisure as evidenced by some disgorged fragments in the case of *P. hochstetteri*, which had been shredded by the radula at one end.

The large spreading foot shown in plate 7 illustrates the suitability of this portion of the animal for capturing the worms by the simple process of crawling over them.

NATURAL ENEMIES OF PARYPHANTA.

The Weka consumes large numbers of the young and half-grown snails, and many of the adult specimens often show marks where they have been pecked by these birds; size and weight apparently preventing the removal of the adult snails from under

the tussock and fern where they live. The Weka always attacks the top of the shells, pecking out the spire and early whorls in order to facilitate the removal of the animal.

INTRODUCED ENEMIES AND PRESENT DAY CONDITIONS
CONTRIBUTING TOWARDS THE GRADUAL
EXTERMINATION OF PARYPHANTA.

The introduced rat is a serious menace, particularly in the lower country, consequently the species *busbyi*, *gillicsi*, *subfusca* and *traversi* are more often affected. The rat eats back the body-whorl from the periphery thus giving access to the major portion of the animal.

Introduced birds such as the thrush have also been observed pecking through the shell and eating the animal, in a similar fashion to their method with the common imported garden snail (Waiopahu Reserve, Levin. A.W.B.P. 8/2/1930).

Indirectly the ravages of the deer on our mountain forests are responsible for killing off large numbers of *Paryphanta*, by thinning out the vegetation and rendering the ridges too dry. Similarly the hand of man in clearing the vegetation from the lower slopes of the mountains has the same detrimental effect of making the bush abnormally dry.

MATERIAL.

For over four years the writer has been collecting material and data for this paper, having personally collected at a number of localities representative of Marlborough, Nelson, Westland, Wellington, Taranaki and Auckland Provinces.

Many interesting and important records however are the result of the generous help of a number of people whose names are mentioned below.

ACKNOWLEDGMENTS.

For collections of specimens the writer is deeply indebted to the following people:—Mr. A. Berry, Kaituna; late Captain J. Bollons, Wellington; Miss V. Chapman, Motueka; Mr. R. E. Clouston, Bainham; Mr. R. Curtis, Mokihinui; Mr. Wm. C. Davies, Nelson; Mr. A. H. Fletcher, Collingwood; Mr. Flowers, Puramahoi; Mr. J. F. Galey, Takaka; Mrs. G. Graham, Bainham; Mr. H. Harvey, Manaroa; Mr. H. Hamilton, Rotorua; Mr. H. Ives, Puramahoi; Mr. F. V. Knapp, Nelson; Dr. Kidson, Wellington; Mr. D. MacKenzie, Paturau River; Miss M. K. Mestayer, Wellington; Mr. Parkinson, Takaka; Mr. Thomson, Takaka; Mr. Wastney, Nelson; and Professor F. P. Worley, Auckland.

The writer also wishes to record his thanks to the following people who generously undertook to make available their knowledge of the country by accompanying the writer on collecting trips:—Mr. R. E. Clouston, Bainham; Mr. Climie, Takaka; Mr.

B. E. Feary, Takaka; Mr. F. G. Gibbs, Nelson; Mr. Langford, Bainham; and Mr. Parkinson, Takaka.

For making references to literature not available in New Zealand the writer's thanks are due to:—Dr. H. J. Pilsbry, Philadelphia; Mr. W. H. Webb, Rochester; and Mr. A. Hartley, Yorkshire.

For the excellent photographs of the living snails, and the plate of *Paryphanta superba* the writer is very grateful to Mr. Wm. C. Davies, Cawthron Institute, Nelson.

Genus RHYTIDA Albers 1860.

Type: *Helix greenwoodi* Gray.

The genus is widely distributed in New Zealand being found wherever forest conditions are suitable. The species can be divided into three groups, one of which is confined to the northern part of the North Island, the second to the South and Stewart Islands, while the third is found in both the North and South Islands.

Rhytida is characterized by its shell which is wrinkled or malleated and composed of more lime and less conchin than in the shell of *Paryphanta*; and also by its radula which is composed of comparatively few teeth. The outermost laterals are very small and are followed by the largest tooth, the succeeding laterals decreasing in size to the centre. Central tooth small or absent.

KEY TO SPECIES DEALT WITH IN THIS PAPER.

A. Periphery of body-whorl keeled.

- (1) Spire low, ratio of height into diameter averaging 1.79. Dental formula $18 + 1 + 18$, five consecutive teeth from margin small, the sixth extra large, then decreasing to centre. Average dimensions 26mm. \times 14.5mm.
dunniac.
- (2) Higher spire, ratio of height into diameter averaging 1.55. Dental formula $15 + 1 + 15$, four consecutive teeth from margin small, and fifth extra large, then decreasing to centre. Average dimensions 30.25mm. \times 19.50mm.
tarangaensis

B. Periphery of body-whorl rounded. Body-whorl with 5 or 6 spiral ribs.

- (3) Ratio of height into diameter averaging 1.62. Dental formula $12 + 1 + 12$, two small teeth at margin, third tooth extra large, then decreasing to centre. Average dimensions 25.57mm. \times 15.78mm. Umbilicus typically coloured dark-brown.
greenwoodi
- (4) Ratio of height into diameter averaging 1.74. Dental formula $13 + 1 + 13$, one small tooth at margin, second tooth extra large, then decreasing to centre. Average dimensions 33.66mm. \times 19.33mm.
stephensis

C. Periphery rounded. Spiral ribs absent.

- (5) Shell microscopically malleated and sculptured with dense microscopic spiral striae. Umbilicus narrow and deep, one thirteenth major diameter. Dental formula $18 + 0 + 18$ (Hutton). One small tooth at margin, second tooth extra large, then decreasing to centre. Dimensions 20.5mm. \times 12mm.
patula
- (6) Shell microscopically malleated, spiral striae absent. Umbilicus wider, one seventh major diameter and aperture smaller than in *patula*. Dental formula $14 + 0 + 14$, largest tooth at margin, then decreasing to centre. Dimensions 17.5mm. \times 10mm.
otagoensis

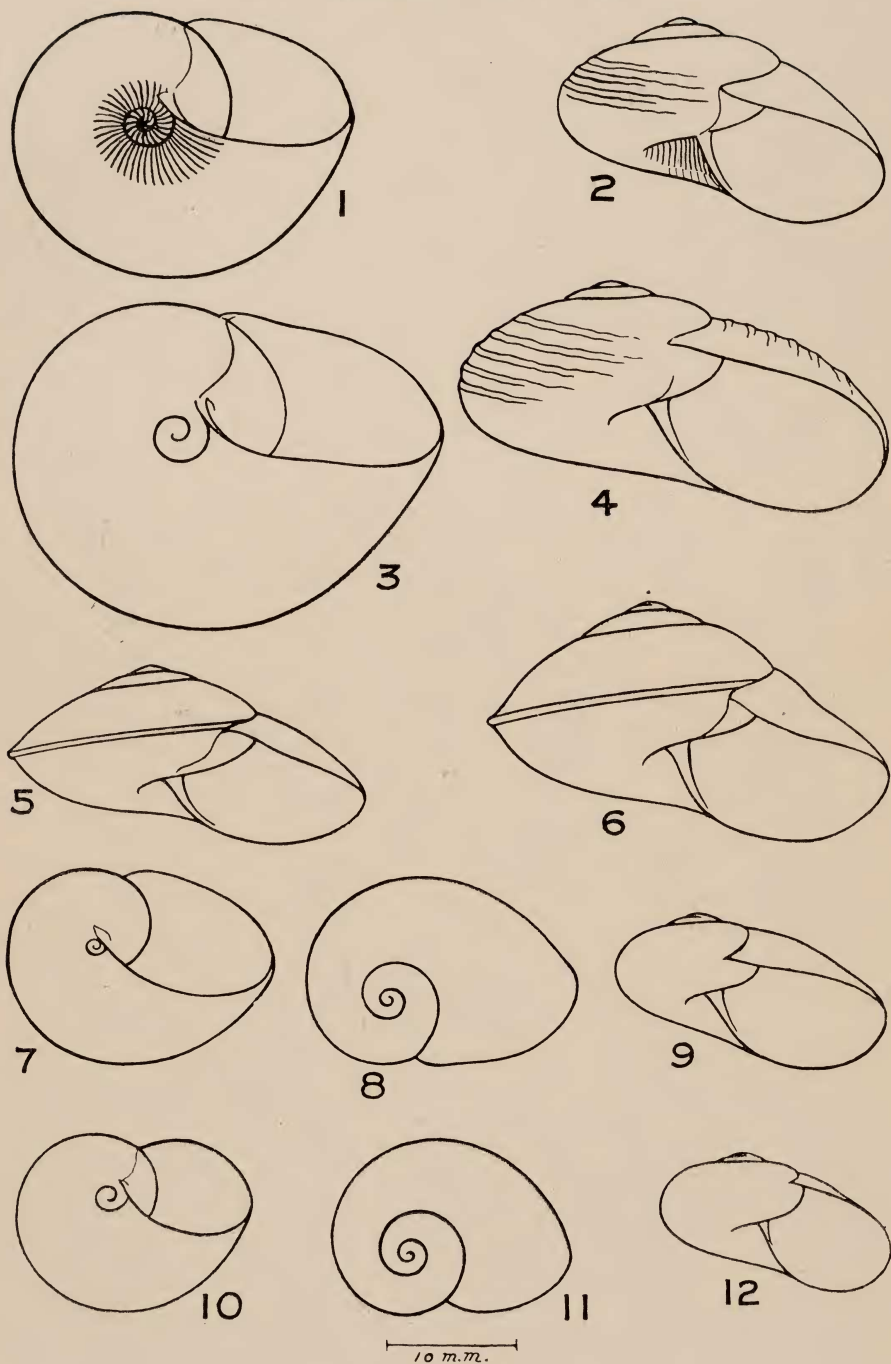


Fig. 3. RHYTIDA.

1 and 2 *Rhytida greenwoodi* (Gray), Muriwai, West Coast.

3 and 4 *Rhytida stephencensis* n. sp., Holotype.

5 *Rhytida dunniac* (Gray), Whangarei.

6 *Rhytida tarangaensis* n. sp. Holotype.

7, 8, 9 *Rhytida patula* Hutton, Mokihinui.

10, 11, 12 *Rhytida otagoensis* n. sp. Holotype.

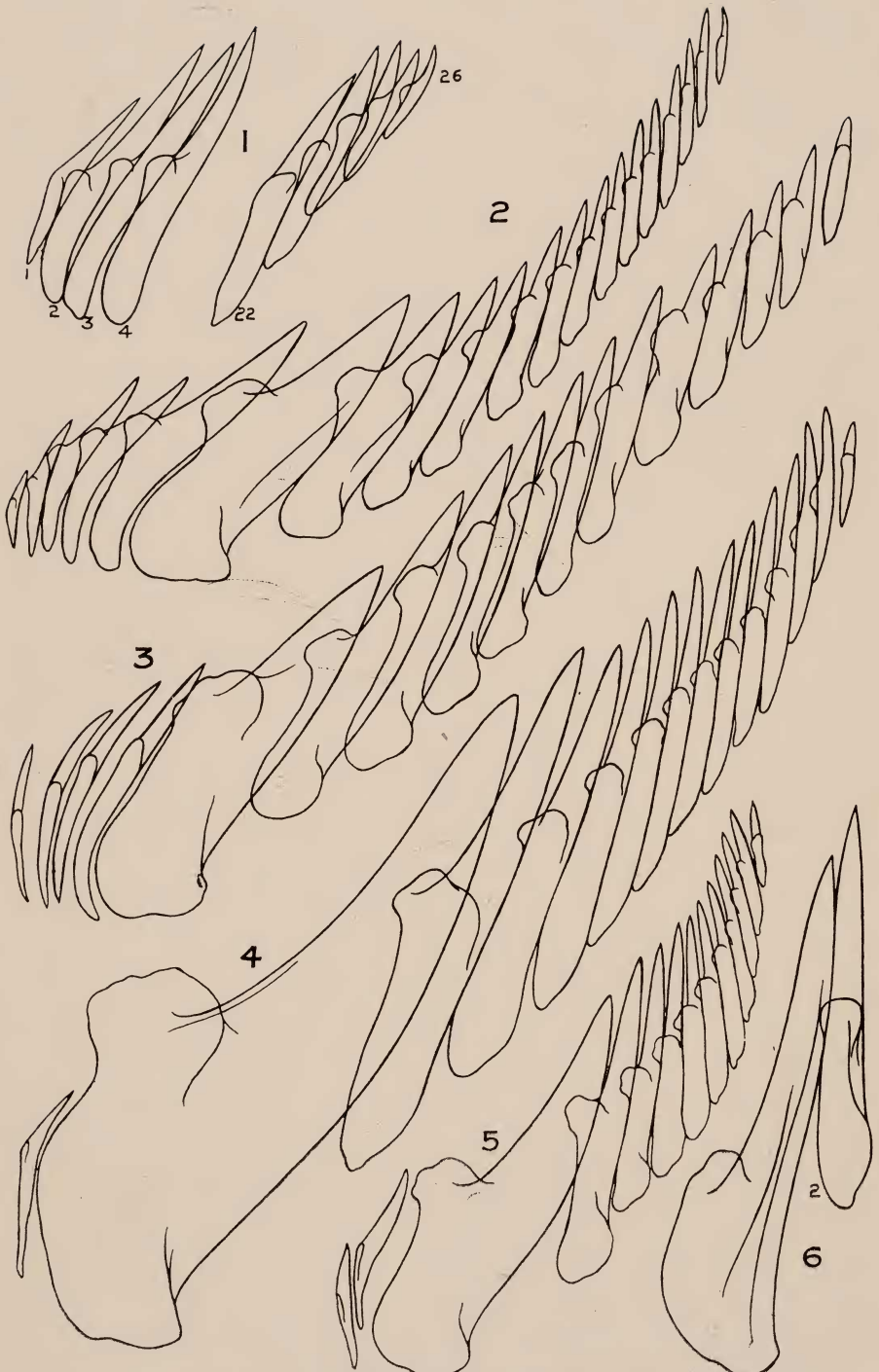


Fig. 4. DENTITION OF SCHIZOGLOSSA AND RHYTIDA.

- 1 *Schizoglossa novoseelandica* Pfeiffer.
- 2 *Rhytida dunni* (Gray).
- 3 *Rhytida tarangaensis* n. sp.
- 4 *Rhytida stephenensis* n. sp.
- 5 *Rhytida greenwoodi* (Gray).
- 6 *Rhytida otagoensis* n. sp.

Rhytida greenwoodi (Gray) (Plate 4, Fig 7 and Text Fig 3, 1 and 2).

1850 *Helix greenwoodi* Gray P.Z.S. p. 165.

1913 *Rhytida greenwoodi* (Gray). Manual N.Z. Mollusca, H. Suter (for full synonymy).

Type from Auckland in the British Museum.

Specimens have been examined from the following localities Muriwai, West Coast, Auckland (a few dead shells, A.W.B.P., 1915); in a small patch of native bush about 3 miles south of Waiuku (sheltering from heat in summer and excessive moisture in winter, in the fallen leaf-sheaths of the "Nikau" palms, A.W.B.P., June 1927 and December 1928); Waikato Heads (Mr. W. La Roche); Opotiki (Mr. D. H. Graham); near Gisborne (Mr. Goffe); Awakino Gorge and Mount Messenger (on the ground under decaying "Ponga" fronds, A.W.B.P., January 1927); Levin (on the ground under decaying "Ponga" fronds, A.W.B.P., Jan. 1927); 10 miles up Takaka Valley, Nelson (a half grown specimen, Dr. J. Henderson, 1922); in a cave on left bank of Lee, Wairoa Valley, Nelson (bleached shell, Mr. F. V. Knapp).

This species has also been recorded from Whangaroa; Kamo; Cuvier Island; East Island; Pukekohe; Mount Pirongia; Cape Kidnappers; Tuhoe-land; Wanganui; Midhurst, Taranaki; and Lake Guyon Run, near source of the Waiiau River, Nelson. (Suter, 1. c. p. 775). The Stephen Island record refers to the next species.

The typical Auckland shells have the umbilicus coloured dark chestnut-brown, while those from the south have this feature entirely lacking. Specimens from Muriwai and Waiuku are 100 per cent. with the brown umbilical patch, from Waikato Heads 75 per cent., and from Awakino Gorge, Mount Messenger and Levin respectively 100 per cent. plain.

Dimensions of three specimens from Muriwai—

Major diameter 27mm.; height 17mm.

Major diameter 27mm.; height 17mm.

Major diameter 26mm.; height 16mm.

Dimensions of four specimens from Levin—

Major diameter 25mm.; height 15.5mm.

Major diameter 25mm.; height 15.0mm.

Major diameter 25mm.; height 15.5mm.

Major diameter 24mm.; height 14.5mm.

Average dimensions—

25.57mm. × 15.78mm.

Dimensions of Muriwai (typical) specimen—

Major diameter 26mm.; minimum diameter 20.5mm.; height 16mm. (Plate 4, Fig. 7.)

Dentition (Text Fig. 4, 5). Formula 12 + 1 + 12. There are two small rudimentary teeth at the margin followed by the third

tooth which is large and massive, far exceeding the size of all the others. The remaining teeth gradually diminish in size towards the centre. The central tooth is small, narrow and straight-sided about two thirds the size of the adjacent laterals. (Waiuku specimens.)

Rhytida stephenensis n. sp. (Plate 4, Fig 8 and Text Fig 3, 3 and 4)

This shell differs from *greenwoodi* in its larger adult size, distinctive dentition, and proportionately lower spire; ratio of height into diameter averaging 1.74 in *stephenensis* as compared with 1.62 in *greenwoodi*.

The five or six obliquely transverse parallel ribs so typical of *greenwoodi* are more pronounced in *stephenensis*, while the radials in this latter species are almost obsolete from the base but strongly developed and irregularly anastomosing over the entire upper surface. Another permanent feature seems to be the absence of the characteristic brown umbilical-patch found in typical *greenwoodi*. Ground colour normally olive-brown, spirit specimens bleached to a yellowish-brown.

Major diameter 34mm.; height 19.0mm.

Major diameter 34mm.; height 19.5mm.

Major diameter 33mm.; height 19.5mm.

Average dimensions, 33.66mm. \times 19.33mm.

Dimensions, of *Holotype*—Major diameter 34mm.; minimum diameter 26mm.; height 19.5mm.

Holotype in Dominion Museum, Wellington. Paratypes in author's collection and Auckland Museum collection.

Habitat—Stephen Island, Cook Strait. (Collected by Mr. H. Hamilton.)

Dentition (Text Fig. 4, 4). Formula 13 + 1 + 13, one small rudimentary tooth at margin, second tooth extremely large and massive exceeding the size of all the others, the remaining teeth gradually diminishing in size towards the centre. The central tooth is small, about two thirds the size of the adjacent laterals.

The formation and arrangement of the teeth are similar to those of *greenwoodi*, except that there is only one small tooth preceding the largest at the margin. In *greenwoodi* there are two of these small teeth at the margin and the dental formula is 12 + 1 + 12.

Rhytida dunniæ (Gray) (Text Fig. 3, 5).

1840 *Helix dunniæ* Gray, A.M. Nat. Hist. (1), 6, p. 317

1913 *Rhytida dunniæ* (Gray). Manual N.Z. Mollusca, H. Suter, p. 773 (for full synonymy).

Type in the British Museum.

Specimens have been examined from the following localities: Takahui, Victoria Valley, Kaitaia (coll. Mr. W. La Roche);

Rawene, Hokianga (coll. Mr. W. La Roche); Whangaroa (coll. Mrs. F. W. Sanderson); Kamo and Parua Bay, Whangarei (coll. Mr. C. Cooper); Whangarei (coll. Mr. A. E. Brookes); Waitakerei., Auckland (coll. Mr. A. Suter); near Cornwallis, Manukau Harb., inside the fallen leaf-sheaths of "Nikau" palms (A.W.B.P. 8/5/1927); "Dreamlands," Henderson Valley, Auckland (with eggs) at the roots of ferns in the open (coll. A.W.B.P., 10/9/1926).

This species has also been recorded from Bay of Islands; Otonga East; Auckland; Howick; and Thames. (Suter l. c, p. 773.) The Hen Island record refers to the next species.

Dimensions of shell—

Major diameter 25.5mm.; height 14.5mm.

Major diameter 26.5mm.; height 14.5mm. (Victoria Valley, Kaitaia.)

Dimensions of egg—

3mm. \times 3.5mm. (Henderson Valley specimens.)

The typical shells have a low spire, ratio of height into diameter averaging 1.79, and the dimensions 26mm. 14.5mm.

Dentition (Text Fig. 4, 2). Formula $18 + 1 + 18$, the first five lateral teeth increasing in size from the margin, the sixth is the largest and the remainder diminish towards the centre. The central tooth is narrow as in *greenwoodi* and about half the size of the adjacent laterals. (Henderson Valley specimens.)

Rhytida tarangaensis n. sp. (Text Fig. 3, 6).

This shell differs from *dunniac* in its larger adult size, sculpture, dentition, and proportionately higher spire; ratio of height into diameter averaging 1.55 in *tarangaensis* as compared with 1.79 in *dunniac*.

The sculpture in *dunniac* is in the form of radiating obliquely-retractive granular-wrinkles, less prominent over the base. In *tarangaensis* the radials are more regular and in the form of close, sinuous, anastomosing raised riblets, evenly developed over the entire shell. Whorls $4\frac{3}{4}$. Colour uniformly yellowish-brown. Periphery angled as in *dunniac*.

Major diameter 31mm.; height 19.5mm.

Major diameter 29.5mm.; height 19.5mm.

Dimensions of Holotype—Major diameter 31mm.; minimum diameter 24.5mm.; height 19.5mm.

Holotype presented to Auckland Museum. Paratypes in collection of A. W. B. Powell.

Dentition (Text Fig. 4, 3). Formula $15 + 1 + 15$. The first four lateral teeth are small and slender, the fifth large and massive exceeding the size of all the others, and the remaining teeth gradually diminish in size towards the centre. Central tooth almost as large as the adjacent laterals but narrower and rather blunt.

Habitat—Taranga (or Hen Island), Hen and Chicken Islands (coll. Mr. H. Hamilton).

Rhytida patula Hutton (Text Fig. 3, 7, 8, 9).

1883 *Rhytida patula* Hutton. Trans. N.Z. Inst. vol. 15, p. 139.

1913 *Rhytida patula* Hutton (in part) Manual N.Z. Mollusca, H. Suter, p. 776.

Type from Greymouth in Canterbury Museum, Christchurch.

Habitat—Greymouth (type) (Helms); Caplestone near Reefton (Cavell); near Mokihinui, towards Corbyvale. (A.W.B.P., 27th December, 1927.)

Dimensions of topotype—Major diameter 20.5mm.; minimum diameter 15mm.; height 12mm.

Dentition—Formula $18 + 0 + 18$ (Hutton). One small tooth at margin, second tooth extra large, then decreasing to centre.

Rhytida otagoensis n. sp. (Text Fig. 3, 10, 11, 12).

Shell of similar shape to that of *patula*, differing in the wider umbilicus, smaller aperture, absence of spiral striae and in the distinctive dentition. Shell thin, covered with a pale greenish-olive epidermis. Whorls $3\frac{3}{4}$, more tightly coiled than in *patula*, resulting in the smaller aperture. Periphery rounded as in the *patula* series. Umbilicus one seventh major diameter. Protoconch flat of $1\frac{1}{2}$ finely radially striated whorls. All post-nuclear whorls sculptured with close slightly irregular radial growth lines. The whole surface microscopically malleated, less prominently on the base. The dense spiral striae so typical of *patula* is entirely wanting in this species.

Dimensions of holotype—Major diameter 17.5mm.; minimum diameter 13.5mm.; height 10mm.

Holotype in author's collection.

Habitat—Bluecliff, western side of Te Waewae Bay, Southland (coll. C. E. Clark, 1920); Hutton's Balclutha, Southland record, quoted by Suter, Man. N.Z. Mollusca, p. 777, also refers to this species, not *patula*, as shown by the dental formula $14 + 0 + 14$.

Dentition (Text Fig. 4, 6). Formula $14 + 0 + 14$. Largest tooth at margin, then decreasing in size to centre. All teeth long and slender. The largest lateral is slightly bent at the middle and has an angular ridge dividing it right from the point to the base.

Genus PARYPHANTA Albers, 1850.

Type: *Nanina busbyi* Gray

The species of *Paryphanta* in New Zealand are covered by two groups, occupying two distinct areas of distribution separated by a gap of about 300 miles. The northern area is represented by *P. busbyi*, a shell having a uniformly dark greenish-black coating of conchin, while the southern area is represented by seven distinct species and three sub-species, all differing from the northern *busbyi* in being variously coloured and banded.

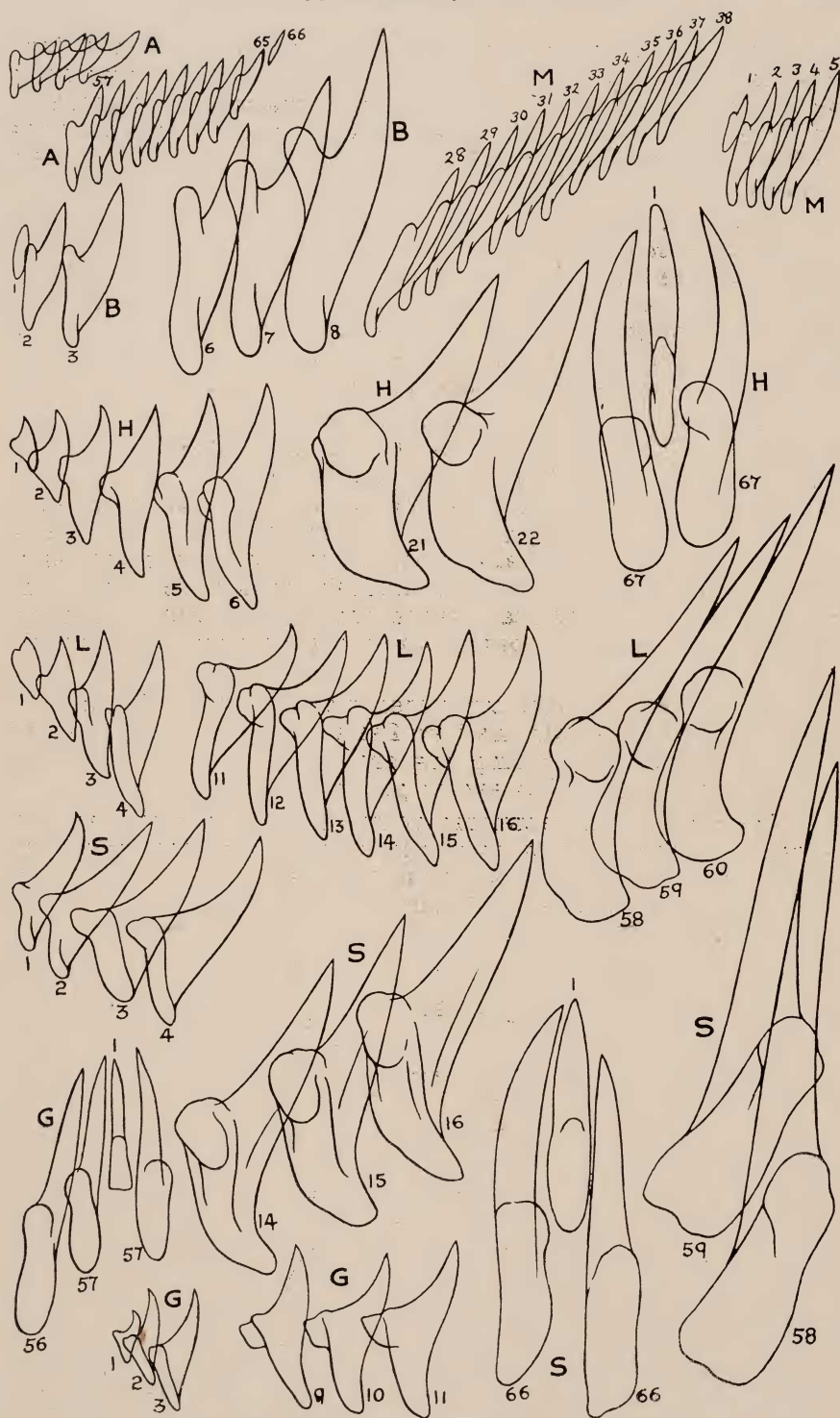


Fig. 6. DENTITION OF PARYPHANTA.

- A. *P. atramentaria* Shuttleworth, Victoria.
- M. *P. milligani* Pfeiffer (= *fumosa*), Tasmania.
- B. *P. busbyi* Gray, North Auckland, N.Z.
- H. *P. hochstetteri* Pfeiffer, Nelson-Marlborough, N.Z.
- L. *P. lignaria* Hutton, West Nelson, N.Z.
- S. *P. superba* n. sp., West Nelson, N.Z.
- G. *P. giliesi* Smith, West Nelson, N.Z.

Radula characters (see under species *busbyi*), and a dark coating of conchin without colour bands are features common to *busbyi* and the Victorian and Tasmanian species, but discordant with the *hochstetteri-lignaria-gilliesi* series which are confined to the Wellington, Marlborough, Nelson and Westland provinces of New Zealand.

However, apart from the close similarity in dentition and coloration, *busbyi* and the Victorian and Tasmanian species show rather diverse anatomical features. Likewise the New Zealand *busbyi* and *hochstetteri* are just as diverse in their anatomy. It seems as though in *Paryphanta* we cannot place any reliance in the genital organs, as pointed out by Murdoch in dealing with the anatomy of the Tasmanian *milligani* (= *fumosa*).

"The most striking peculiarity in the anatomy of the several known species of *Paryphanta* is the marked difference in their genital organs. The difference is chiefly centred in the receptaculum seminis; the contour of this organ is so distinct in each species that, when added to the minor difference in other organs, it presents a type of genitalia unusually distinct among species of the same genus. *P. busbyi* can scarcely be compared with the other members, its genital organs are almost totally different; but this condition is probably due to degeneration." (Murdoch, 1904, p. 160.)

The genus no doubt originated from ancestral *Rhytida* like stock somewhere within the New Zealand area, and achieved its greatest distribution during the great land extensions of the Lower Cretaceous. (See earlier part of this paper.)

Paryphanta is characterized by its shell which is formed very largely of conchin and by its radula which is composed of a large number of aculeate laterals gradually increasing in size from the margin and then decreasing again towards the centre.

KEY TO SPECIES OF PARYPHANTA.

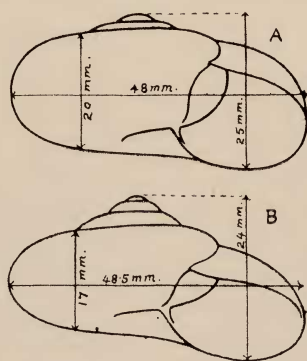


Fig. 5.

Group A. Shell composed of an inner layer of lime with a thick outer coating of uniformly dark brownish-green conchin. One species in New Zealand. North Auckland Peninsula.

(1) Large shell. Dental formula $50 + 0 + 50$.

busbyi

Group B. Shell composed of very little lime but a thick outer covering of conchium, variously coloured and banded. A number of species distributed over the south-western part of the North Island and the northern and western parts of the South Island.

(a) The *hochstetteri* series.

Spirally banded or plain shells up to 87mm. in width. Restricted to the mountains of Marlborough and Nelson; typical species at 2,000 feet and over. Shell proportions as in diagram A, Text Fig. 5.

- (2) Shell large, up to 75mm. in width. Ground colour light yellowish-brown above and below, variously spirally banded with dark-brown. Umbilical area always free from colour bands. Dorsal surface to periphery spirally striated. Dental formula $67 + 1 + 67$. Pikikiruna, Tasman and Haupiri Ranges at 2,000 to 4,000 feet.

hochstetteri hochstetteri

- (3) Slightly smaller than typical species, up to 58mm. in width. Ground colour light olive or greenish-brown above, with spiral bands and lines of dark-brown as in typical species. Base uniformly dark-brown or almost black, sometimes broken up into one or two spirals towards periphery. Umbilicus never light coloured as in typical species. East Nelson mountains and Western Marlborough Sounds area at 2,000 to 4,000 feet.

hochstetteri obscura

- (4) About same size as *obscura*, up to 61mm. in width. Dark colour of the base confined to umbilicus and a small surrounding area, remainder of base free from bands. Dorsal surface banded as in typical species and with same dental formula. Eastern Marlborough Sounds area at 2,500 to 4,000 feet.

hochstetteri bicolor

- (5) Largest species of genus, up to 87mm. in width. Colour uniformly yellowish-olive without colour bands. Smooth above and below. Dental formula $66 + 1 + 66$. Eastern side of Aorere Valley and Rocks Point, Karamea at 1,100 to 2,500 feet.

superba

(b) The *lignaria* series.

Axially banded or plain shells restricted to the West Coast of the South Island. From a few hundred feet above sea-level to 2,900 feet and probably over. Shell proportions as in the *hochstetteri* series, diagram A, Text Fig. 5.

- (6) Shell large, up to 68mm., alternately banded with yellowish and dark-reddish-brown axial streaks. Dorsal surface striated. Dental formula $70 + 1 + 70$. Karamea to north side of Mokihinui River, from 120 feet to 1,000 feet and probably over.

lignaria

- (7) Smaller than *lignaria*, up to 45mm., and uniformly olive-brown without axial streaks. Dorsal surface striated. Dental formula $54 + 1 + 54$. Seddonville, on south side of Mokihinui River to near Westport, from about 300 feet.

unicolorata

- (8) Smaller than above species, 35mm. Entire surface smooth. Dark greenish-brown, irregularly axially streaked with darker brown. Mt. Greenland 2,900 feet, Ross, Westland.

rossiana

(c) The *gilliesi* series.

Spirally banded shells up to 50mm. in width. From near sea level to about 2,000 feet and restricted to Northern Nelson and Western Wellington Provinces. All species with striated dorsal surface. Parietal callus smooth or granulated. Shell proportions as in diagram B, Text Fig. 5.

- (9) Parietal callus strongly granulated. Under side bright red-brown. Large umbilical dark patch with clearly defined edge. Periphery with from one to four broad black bands. Dental formula $59 + 1 + 59$. Northern Whakamarama Range, West Nelson.

gilliesi gilliesi

- (10) Parietal callus strongly granulated. Same as above species but without basal dark patch. Periphery with four or five strong dark-brown bands. Southern Whakamarama Range, West Nelson.

gilliesi (variety A)

- (11) Parietal callus strongly granulated. Under side olive-brown, gradually deepening to dark-brown in and around umbilicus. Two or three narrow dark bands at periphery. No other dark bands showing on base. Dental formula $64 + 1 + 64$. Low country north side of West Haven Inlet, West Nelson.

gilliesi subfusca

- (12) Parietal callus obscurely granulated. Ground colour golden to sienna-brown, base slightly darkened in and around umbilicus by a zone of crowded faint brownish or greenish spiral lines. Upper surface variably banded with dark-brown spiral lines and a light greenish secondary series. Dark bands strongest at periphery and absent from base. Eastern side Aorere Valley, West Nelson. *compta*
- (13) Parietal callus smooth. Colour greenish to chocolate-brown, variably marked with numerous narrow spiral bands of dark greenish and reddish-brown with a secondary series of lighter colour in the form of wavy spiral lines and zones. The strongest bands are at the periphery and are from three to five in number. Base dark chocolate-brown, lighter towards outer part, allowing lower peripheral spirals to show. Ngarino and Onekaka Ridges, West Nelson. *fallax*
- (14) Parietal callus smooth. Colour light greenish-brown, variably marked with narrow dark-brown spiral bands, one or two strong ones at periphery, a few on the upper surface, more numerous on the base. Dental formula $65 + 1 + 65$. Plains around Levin, North Island. *traversi*

***Paryphanta busbyi* (Gray).**

1840 *Helix busbyi* Gray. Ann. Mag. Nat. Hist. (1), vol. 6, p. 317.

1913 *Paryphanta busbyi* (Gray). Manual N.Z. Mollusca, H. Suter, p. 778 (for full synonymy).

Type in British Museum.

Habitat—Northern parts of the North Island; Kaitaia; Hokianga; Mangonui; Bay of Islands; Otonga East; Mania Hill, Whangarei. (Suter, 1. c., p. 779.)

The following additional localities are worthy of note: Poor Knight's Islands (Mr. Baker, Bay of Islands, 1923); Taranga, Hen and Chicken Islands (Mr. H. Hamilton, 1925); Awanui (Mr. W. La Roche, 1923); and near Araparera, Makarau, Kaipara (Mr. G. Graham, 1921).

Dentition (Text Fig. 6, B.). Formula $50 + 0 + 50$. The individual teeth of *busbyi* differ from those of the remaining New Zealand species in the form of the base, which is produced above forming a deep sinus between this basal projection and the cusp. In all the species of the *hochstetteri-lignaria-gilliesi* series so far examined the upper extremity of the base terminates in a large irregular knob but is not produced upwards as in *busbyi*.

The Victorian *atramentaria* and *compacta* and the Tasmanian *milligani* (= *fumosa*) each have the bases of the teeth shaped as in *busbyi*.

Major diameter 66mm.; minimum diameter 53mm.; height 29mm. (type).

Major diameter 79mm.; minimum diameter 61mm.; height 42mm. (large specimen from near Dargaville).

Eggs—Length 12.5mm.; width 10mm.

Length 12mm.; width 9.5 mm. (Broadwood, Hokianga.)

This species is the well known "Kauri-snail" or "Pupurangi".

Paryphanta hochstetteri (Pfeiffer).

- 1862 *Helix hochstetteri* Pfeiffer, *Mal. Bl.*, 8, p. 146.
 1868 *Helix hochstetteri* Pfeiffer, *Monog. Heliceorum Viventium*,
 vol. 5, p. 48.
 1867 *Helix hochstetteri* Pfeiffer, *Hochstetter's "Neu Seeland"*,
 p. 434, Fig. in text; English edition, p. 169.
 1895 *Paryphanta hochstetteri* (Pfeiffer), in Travers *Trans. N.Z.*
Inst., vol. 27, 27, pp. 224-225.
 1913 *Paryphanta hochstetteri* (Pfeiffer), in part, Suter, *Man.*
N.Z. Mollusca, pp. 781-785.

Pfeiffer (1868) gave the locality of his *Helix hochstetteri* as "Habitat in Alpihus calcareis Novae Seelandiae (v. Hochstetter)".

The illustration in Hochstetter's "Neu Seeland," p. 434, Fig. in text, and p. 169 (English edition) clearly shows that the upper and lower surfaces of the shell were similarly marked with spiral bands on a light ground. Shells from the Pikikiruna Range between Motueka and Takaka fit this description, and the fact that these mountains are covered with great outcrops of marble, strongly suggests that the type locality "in Alpihus calcareis Novae Seelandiae" was somewhere on the Motueka or Takaka side of the Pikikiruna Range.

W. T. L. Travers (l. c, p. 224) mentioned that Hochstetter's first specimen was found near some ponds on the Dun Mountain Pass, between Nelson and the Pelorus Valley. This spot is marked on the Geological Survey map as the saddle on the old Mokatapu Track (2,952ft.). All specimens the writer has seen and personally collected from this spot have the whole of the base dark without any definite banding, quite unlike Hochstetter's figure.

Beutler in describing this dark-based form as a new subspecies *obscura* mentioned that it differed from the typical *hochstetteri* by the colour of the under-side; the typical form having a pale ground colour below as well as above.

We may conclude therefore that Hochstetter's first specimen was not made the type of Pfeiffer's species and that the actual type specimen as described and subsequently figured by Hochstetter came from the Pikikiruna Range.

A specimen in the writer's collection from Mt. Campbell on the Motueka side of the Pikikiruna Range has been selected as a Plesiotype of Pfeiffer's species and is here figured. (Plate 1, Fig 1).

DESCRIPTION OF TYPICAL SPECIES

Paryphanta hochstetteri hochstetteri (Pfeiffer) (Plate 1, Figs 1 and 2)

Shell very large, depressed, umbilicated. Dorsal surface sculptured with minute wavy spiral striae, abruptly terminated at periphery. Ventral surface smooth. Ground colour light yellowish-brown irregularly banded with dark-brown or reddish

spiral bands and lines, varying in tone from every shade of brown to almost black. In some specimens the bands have a tendency to become fewer and wider on the base, but in most specimens the upper and lower surfaces are approximately similarly banded. However variable the banding, all specimens conform in having the pale ground colour of the umbilical area entirely free from bands or dark colour zone.

Dimensions of shells (Page's Saddle near Canaan)

Major diameter 74.5mm.; minimum diameter 60mm.; height 35mm.

Major diameter 70mm.; minimum diameter 59mm. height 31mm.

Major diameter 67mm.; minimum diameter 57.5mm.; height 35mm.

Major diameter 64mm.; minimum diameter 53mm.; height 31mm.

Dimensions of egg—Length 12.5mm.; width 10.5mm. (Takaka Saddle, one old specimen with worn surface, original colour probably dull-white).

Habitat—Pikikiruna, Tasman and Haupiri Ranges, Nelson. Above saddle, main road between Motueka and Takaka at about 2,900 feet, on the ground under several inches of decaying leaves in Beech forest (narrow banded specimens, A.W.B.P. Dec. 1927); Mt. Campbell, west of Motueka at about 2,500 feet (Miss V. Chapman, 1927, narrow banded specimens); near Canaan, 2,500-3,000 feet, situated between the main road saddle and the coast (narrow to broad banded specimens, Mr. Chapman, 1927); Page's Saddle, 2,200 feet, between Takaka and Canaan on the main range (living under decaying leaves around the roots of old moss-covered tree trunks and among blocks of limestone, B. E. Feary and A.W.B.P., 27/1/1930; narrow to broad banded specimens). Records covering practically the whole extent of the Pikikiruna Range from near Separation Point to Mt. Arthur inclusive have been given by residents of Takaka and Motueka. The following records from the Tasman and Haupiri Ranges suggest that in all probability the species has a continuous distribution over the connected mountain systems, embracing these localities and those of the Pikikiruna Range. Walker's Ridge at about 3,000 feet, between the Waikoromumu and Anatoki Rivers (Mr. J. F. Galey); Flower's Track, 2,000-3,000 feet, Parapara Peak (A.W.B.P., Jan. 1930); and Goulard Downs (Mr. R. E. Clouston).

Dentition (Text Fig. 6H). Formula $67 + 1 + 67$. Central tooth smaller than adjacent laterals which are long and slender, very gradually decreasing in size towards margin where they become short and triangular shaped.

***Paryphanta hochstetteri obscura* Beutler (Plate 2, Figs 1 and 2).**

1901 *Paryphanta hochstetteri obscura* Beutler, *Zool. Jahrbucher, Anat.*, vol. 14, p. 369.

1913 *Paryphanta hochstetteri obscura* Beutler, *Man. N.Z. Mollusca*, H. Suter, p. 783.

The writer is indebted to Dr. H. A. Pilsbry for the following translation and notes from the original description, which is not available in New Zealand.

"The species was collected by Professor Schauinsland from the vicinity of Elmsley Bay, N.Z."

"The shell is of greenish-brown colour and traversed by about 13 dark-brown, weakly wavy stripes of unequal breadth. On the under side the shell is dark-brown, nearly black" (translation).

"It is said to differ from the typical *hochstetteri* by the colour of the under side; the typical form having a pale ground colour below as well as above."

Topotypes presented by Professor F. P. Worley have been examined by the writer and one is here figured. In these typical shells the ground colour varies from greenish-brown to yellowish olive. The upper surface is banded with dark-brown spiral lines varying in number and width, but the base is constant in being almost completely covered with a uniformly dark-brown or almost black zone. Towards the periphery this zone is often broken up into from two to six spiral bands.

This subspecies is distributed over the Western Marlborough Sounds area and along the East Nelson mountains from French Pass to Gordon's Knob near Tophouse.

Dimensions of shells—

Major diameter 56mm.; minimum diameter 46mm.; height 26mm. (Topotype)

Major diameter 47mm.; minimum diameter 38mm.; height 24.5mm. (Topotype)

Major diameter 56mm.; minimum diameter 48mm.; height 31mm. (Mt. Stokes)

Major diameter 49mm.; minimum diameter 41mm.; height 25mm. (Koromiko)

Major diameter 58mm.; minimum diameter 50mm.; height 32mm. (Saddle Hill)

Habitat—Elmslie Bay, French Pass (Type); near Admiralty Bay (Captain Bollons); Stephen Island (Captain J. Bollons); on range near Koromiko, western side of Tuamarina Valley (Miss M. K. Mestayer); saddle on "Old Mokatapu Track," 2,952 feet, East Nelson mountains (living around roots of tussock, *Gahnia procera* Forst., A.W.B.P., 2/2/1930); Saddle Hill, east of Nelson at about 3,000 feet (A.W.B.P., 13/1/1930); on the ridge running from Wangamoa Saddle to Mt. Duppa at 2,500 to 3,000 feet (Mr. Wastney and Dr. Kidson); on the slopes of Mt. Kiwi and Mt. Stokes, 2,000-3,000 feet, Marlborough Sounds (H. Harvey, 1928). Local residents report this subspecies from Mt. Starveall and Gordon's Knob.

In the four Mt. Duppa specimens the basal dark patch is rather smaller than in typical shells, but a series of specimens is required before this character is known to be constant.

Dentition—Suter (1913) gave the dental formula as $59 + 1 + 59$, presumably quoting from Beutler's paper. Unfortunately no adult live specimens have been at the writer's disposal.

Paryphanta hochstetteri bicolor n. subsp. (Plate 2, Figs 3 and 4).

Shell about the same size as *hochstetteri obscura* but never attaining the size of the typical species. The subspecies *bicolor* is distinguished from *obscura* by the colour of the under-side of the shell, which is a light yellowish-olive, free from banding with the exception of a small dark-brown patch in and around the umbilical area.

This colour form is quite constant over the Eastern Queen Charlotte Sounds district but owing probably, to former imperfect isolation at the head-waters of the present Sounds, colonies of both *bicolor* and *obscura*, together with occasional hybrids are now found over the country intermediate between the two Sounds. To the west of the Pelorus on Stephen Island and on the range extending from French Pass to the saddle near Top-house the subspecies *obscura* is found to the exclusion of *bicolor*, suggesting that for a considerable time topographic conditions were responsible for the segregation and evolution of these two colour forms into an eastern and a western type, but comparatively recent changes have again facilitated intercourse between these two types resulting in an intermingling and a certain number exhibiting hybrid characteristics.

The Eastern Queen Charlotte Sounds colonies, however, are now completely isolated from the Western Sounds area by the Tuamarina Valley and the Sound, the connecting land not exceeding 250 feet in height. Every specimen of a large series collected from this area had the typical *bicolor* base.

With regard to the suggested hybrids it is well known that the sexes are united in each individual but on the other hand it is also known in the case of the true *Helicidae* that the union of two individuals is required for mutual impregnation.

As the two colour forms are constant in their extreme districts and are found to intermingle only where separation has not been perfect they can be considered distinct geographic races and are entitled to subspecific distinction on this account.

Description of holotype —

Ground colour of whole shell light yellowish-olive. Dorsal surface marked with a few irregular spiral bands of dark-brown becoming stronger towards periphery. Base entirely free from bands with the exception of a circular patch of dark chocolate-brown in and surrounding the umbilical area. Interior of aperture and parietal callus light to dark purplish-brown.

Of the few live specimens collected and the hundreds of dead specimens seen at the type locality not one showed any marked variation.

Major diameter 61mm.; minimum diameter 51mm.; height 31mm. (Holotype)

Major diameter 56mm.; minimum diameter 47mm.; height 27mm.

Major diameter 56mm.; minimum diameter 47mm.; height 30mm.

Major diameter 57mm.; minimum diameter 47mm.; height 30mm.

Holotype presented to Auckland Museum.

Habitat—Mt. Piripiri, east of Picton, 2,700-3,000 feet (type), living on the ground under dead leaves around the roots of the fern *Blechnum discolor* Forst. (A.W.B.P., Dec. 1928); Arapawa Island, Queen Charlotte Sound (Miss M. K. Mestayer); Ocean Bay, Port Underwood (Captain J. Bollons); on the Range near Koromiko, western side of Tuamarina Valley, together with *obscura* (Miss M. K. Mestayer); on the slopes of Mt. Kiwi and Mt. Stokes, 2,000-3,000 feet. Of the 27 specimens received, 12 were typical *bicolor*, 6 typical *obscura* and 9 exhibited hybrid characteristics as evidenced by the colour pattern (H. Harvey, 1928). These assumed hybrids have the umbilical colour patch, but the remainder of the base is crowded with numerous colour lines and ill defined bands.

Dentition—Formula $67 + 1 + 67$, the same as in the typical species.

Much field work is required in order to accurately map the respective areas of distribution of this and the previous subspecies.

Paryphanta superba n. sp. (Plate 4, Fig. 3 and Plate 3).

Shell very large, sub-discoidal, umbilicated, thin, smooth and glossy. Colour of protoconch yellowish, early spire whorls dark-brown, remainder of shell uniformly yellowish-olive. Interior of aperture and parietal wall deep chocolate-brown. Whorls $5\frac{1}{2}$ including protoconch of one small smooth flat whorl, nucleus slightly sunken. First four whorls closely coiled then rapidly increasing and inclined downwards towards aperture. Upper spire whorls only slightly raised above body-whorl. Base and body-whorl evenly convex. Umbilicus shallow, about one fifth major diameter of base. Sutures impressed. Both dorsal and ventral surfaces of shell smooth and glossy, crossed by numerous slightly retractive, regularly spaced axial growth folds, more prominent towards sutures. Aperture lunate-oval. Peristome discontinuous, thin, advancing above. Parietal callus thin, dark-brown, terminating abruptly.

Major diameter 77mm.; minimum diameter 65mm.; height 38mm. (holotype).

Major diameter 80mm.; minimum diameter 67mm.; height 40mm. (paratype).

Major diameter 87mm.; minimum diameter 75mm.; height 50mm. (Rocks Point specimen).

Holotype in author's collection, paratypes in Auckland Museum collection; Rocks Point specimens in Cawthron Institute collection, Nelson.

Habitat—"Cedar Creek Ridge," at about 2,500 feet (type), between the Boulder and Clark Rivers: this ridge runs from the Quartz Ranges to the slopes of Lead Hills, eastern side of the Aorere Valley. Living around the roots of tussock, *Gahnia procera* Forst. in stunted sub-alpine forest consisting mainly of mountain beech, cedar and *Dracophyllum* (collected by the writer, accompanied by Mr. R. E. Clouston, of Bainham); five miles south of Rocks Point, north of Karamea Bight and one mile from the sea at 1,100 feet (coll. Mr. Wastney, Nelson).

Probably this species occurs right through the Goulard Downs region, connecting the two localities given above.

Dentition (Text Fig. 6, S). Formula $66 + 1 + 66$. Central tooth narrow and about half the height of adjacent laterals. Lateral teeth very similar to those of *hochstetteri*.

This handsome snail is the largest species of the genus. It is allied to *hochstetteri* but lacks the characteristic colour bands and dorsal striae.

The writer is much obliged to Mr. Wm. C. Davies of the Cawthron Institute, Nelson, for the fine photographs illustrating this species.

Paryphanta lignaria Hutton (Plate 4, Fig. 1).

1888 *Paryphanta lignaria* Hutton, Trans. N.Z. Inst., vol. 20, p. 43.

1913 *Paryphanta lignaria* Hutton (in part), Manual N.Z. Mollusca, p. 783.

Type from saddle between Mokihinui and Lyell Rivers, Nelson Province.

This species is undoubtedly our most handsome land snail. Typical shells are exquisitely radially banded with alternating yellowish and dark reddish-brown stripes. In occasional specimens the brown bands are quite wide but the yellowish ones are invariably narrow. The dorsal surface to the periphery is microscopically sculptured with close uneven spiral striae. There are in addition several slightly stronger shallow spiral furrows towards the upper suture. Whorls 5 to $5\frac{1}{2}$ including protoconch.

Hundreds of dead shells were observed by the writer during December 1927; on the ground in native forest at from 100 to 200 feet above sea-level, near St. Helens, Mokihinui. They all showed the characteristic alternate banding and although an exhaustive search was made only one living specimen was found, the majority being dead shells, badly cracked and broken due to an unusually prolonged dry spell.

Mr. R. Curtis, of St. Helens, stated that living specimens were frequently seen crawling in the open across bush-tracks after rain. He later sent eight living specimens collected after rain from under logs and uprooted trees.

Both Hutton's (1900, pl. 2) and Suter's (1915, pl. 32) figures represent a new species, described below, which is always uniformly coloured and devoid of bands. This latter species is confined to the coastal area from the south side of the Mokihinui

River to near Westport while the typical banded *lignaria* is found from the north side of the Mokihinui to Karamea.

Dimensions of three specimens of typical *lignaria* from St. Helens. Major diameter 48mm.; minimum diameter 39.5mm.; height 27mm. (figured specimen).

Major diameter 59mm.; minimum diameter 49.5mm.; height 34mm.

Major diameter 68mm.; minimum diameter 57mm.; height 39mm.

Holotype in Canterbury Museum, Christchurch.

Habitat—Saddle between Mokihinui and Lyell Rivers (type). About $1\frac{1}{2}$ miles up Marris' Tramway, near junction of Mumm and Stillwater Creeks at 120 feet, north side of Mokihinui River, West Coast, Nelson (coll. A.W.B.P., Dec. 1927); near Corbyvale at 1,000 feet (coll. Dr. P. Marshall, Geological Survey collection, Wellington); Karamea (Dominion Museum coll.).

Dentition (Text Fig. 6, L). Formula $70 + 1 + 70$. Central tooth same size as adjacent laterals. Individual teeth similar to those of *hochstetteri*.

Paryphanta unicolorata n. sp. (Plate 4, Fig 2, and Plate 6, Fig 6).

1900 *Paryphanta lignaria* Hutton (not of Hutton 1888). Trans. N.Z. Inst. vol. 32, p. 22, pl. 2.

1915 *Paryphanta lignaria* Hutton (not of Hutton 1888). Manual N.Z. Mollusca, Atlas of plates Pl. 32, Figs. 12, a, b.

Shell moderately large and solid, subdiscoidal, narrowly umbilicated, smooth below, striated above. Colour uniform olive-brown with exception of first post-nuclear whorl which is dark reddish-brown. Whorls more rapidly increasing than in *lignaria*, $4\frac{1}{2}$ including smooth protoconch of $1\frac{1}{2}$ whorls; body-whorl proportionately larger, more expansive towards aperture and slightly more narrowly rounded at periphery. Spire bluntly rounded and slightly elevated. The dorsal surface to the periphery is sculptured with close delicate uneven spiral striae but finer and less conspicuous than in *lignaria*. Umbilicus as in *lignaria*, small, about one ninth major diameter of base. Aperture lunate-oval. Peristome discontinuous, thin, overhanging above. Parietal wall covered by a thick bluish-white callus.

Dimensions of holotype—

Major diameter 45mm.; minimum diameter 36.5mm.; height 26mm.

Dimensions of eggs—

Length 8.5mm.; width 8.25mm.

Length 9mm.; width 7.5mm.

Colour of eggs—Dull olive-brown.

Holotype in author's collection.

Habitat—Seddonville, West Coast, Nelson (type) (a number of specimens collected from around flax (*Phormium*) bushes by the late Clement L. Wragge, 1908). Also a series of live specimens from Seddonville in collection of Dr. E. N. Drier, collected

by Mr. R. Curtis; Mt. Rochfort, near Westport (Hutton's 1900 figured specimen and Suter's 1915 copy of the same plate).

Dentition—Formula $54 + 1 + 54$. Central tooth two thirds size of adjacent laterals. Individual teeth similar to those of *lignaria* and the *hochstetteri* series.

***Paryphanta rossiana* n. sp.** (Plate 4, Figs. 4, 5 and 6).

Shell sub-globose, moderately large, narrowly umbilicate, smooth and glossy. Shell substance thin, composed almost entirely of conchium with exception of a thin internal calcareous film. Colour dark greenish-brown, irregularly axially streaked with slightly darker brown co-incident with the growth periods. Apical whorls light in colour, first half whorl white, next whorl light grey merging first into chestnut-brown and then into the dark greenish-brown of later whorls. Whorls rapidly increasing, $4\frac{1}{2}$, including protoconch of $1\frac{1}{2}$ smooth almost flat whorls. Adult whorls broadly rounded at periphery. Spire low, bluntly rounded, very little raised above body-whorl. Umbilicus small, deep, about one tenth major diameter of base. Aperture lunate-oval. Peristome discontinuous, thin, advancing and overhanging above towards centre of whorl, strongly retracted on either side and over base. Parietal callus dark greyish, caused by a thin, dull, semitransparent veneer of callus over the dark greenish-brown body-whorl.

Major diameter 35mm.; minimum diameter 27.5mm.; height 19mm.

Holotype the only known specimen in author's collection.

Habitat—At the top of Mt. Greenland, 2,900 feet, Ross, Westland (collected alive by Mr. H. Hamilton, March, 1910).

Dentition unknown, animal not preserved.

The obscure axial banding of *rossiana* suggests relationship with *lignaria* but this latter species differs in having a striated upper surface and a moderately heavy calcareous layer.

The southern range of the genus is extended considerably by the finding of this beautiful species.

***Paryphanta gilliesi* E. A. Smith.**

1880 *Paryphanta gilliesi* Smith, Ann. Mag. Nat. Hist., ser. 5, vol. 6, p. 159.

1913 *Paryphanta gilliesi* Smith, Manual N.Z. Mollusca, H. Suter, p. 781.

The type locality for *gilliesi* was given as Whakamarama Mountain, Collingwood, but the name Whakamarama does not refer to any particular mountain but to a coastal range extending for about thirty miles, from the coast near Collingwood to the Goulard Downs. This range terminates within three miles of Collingwood township in a mountain of bold outline known as Mt. Burnett. The accessibility of Mt. Burnett to Collingwood, combined with the original description of the species are the reasons for assuming that Smith's type came from this particular part of the range.

Fortunately there is only one species of *Paryphanta* so far known to occur on or in the vicinity of the Whakamarama Range. There are three distinct colour forms however, one being restricted to the low country around the shores of West Haven Inlet which could hardly be termed Whakamarama Mountain, while the second is found on both slopes along the southern section of the range and the third here considered the typical form is found on the northern extremity of the range near Collingwood.

With regard to the dimensions of Smith's type the height given is less than that of any specimen of similar diameter so far observed but this can be accounted for by the shrunken condition of the type specimen, which fact is mentioned in the original description. Smith's description is lacking in detail making the task of identification impossible without recourse to topotypes. Suter (1915, Pl. 48, Fig. 13) provided a figure which he ascribed to *gilliesi* but did not state its origin. This figure appears to have been taken from the Dominion Museum specimen mentioned by Suter (1913, p. 781) as shown by the peculiar contour of the peristome towards the umbilicus. The Dominion Museum specimen shows this same feature which is adventitious, having been brought about by warping of the shell, which is now a shapeless mass, broken and collapsed in drying or through exposure to sunlight. Enough remains however to show that without doubt the Dominion Museum specimen is a half grown example of the common Whakamarama shell.

In order to definitely fix the characters of *gilliesi* a plesiotype from Mt. Burnett in the Auckland Museum collection is here described and figured.

***Paryphanta gilliesi gilliesi* Smith (Plate 5, Figs 3 and 4, and Plate 6, Fig. 1).**

Shell moderately large, umbilicated. Dorsal surface sculptured with minute wavy spiral striae abruptly terminated at periphery. Ventral surface smooth and glossy. Colour of protoconch pale yellow, spire whorls umber toning to burnt-sienna-brown, variably marked with numerous narrow dark-brown and reddish-brown spiral lines. Periphery with either one broad black band or two, three, and sometimes four smaller bands occupying the same position. On the base there is a broad band of ground colour between the peripheral bands and a uniformly dark-brown almost black clearly defined patch filling and surrounding the umbilical area. The ground colour of the base where not obscured by peripheral bands and umbilical patch is a bright reddish-brown like rosewood. Interior of aperture and parietal callus dark-brown almost black in fresh specimens. Whorls slowly increasing, five, including protoconch of one and a half almost flat, slightly sunken, roughly striated whorls. Spire low, rounded, only slightly raised above body-whorl. Base and body-whorl evenly convex. Umbilicus narrow one eighth major diameter of base. Parietal callus distinctive, always covered with fine granulations even in juvenile shells.

Major diameter 41mm.; minimum diameter 33.5mm.; height 28.5mm. (plesiotype)

Major diameter 46mm.; minimum diameter 36mm.; height 23mm.

Major diameter 48.5mm.; minimum diameter 41mm.; height 24mm.

Major diameter 35mm.; minimum diameter —; height 14mm. (Smith's type).

Major diameter 35mm.; minimum diameter 29mm.; height 20mm.

Holotype in British Museum. *Plesiotype* in Auckland Museum.

Habitat—Mt. Burnett, Collingwood, Nelson. Near the top at 1,900-2,000 feet, living on the ground under decaying leaves among blocks of marble in stunted sub-alpine forest (A.W.B.P., Jan., 1930).

Eggs pale-buff, surface smooth but dull. Length 9mm., width 8.25mm.

Food—These snails feed upon the common bush earth-worms. The writer has removed from a living specimen an entire worm $8\frac{1}{2}$ inches in length. (See note elsewhere in this paper.)

Dentition (Text Fig. 6, G). Formula $59 + 1 + 59$. Central tooth about two-thirds size of adjacent laterals.

The permanent features of typical *gilliesi* are the granulated parietal callus, deep red-brown colour of the under side and the large sharply defined dark patch filling and surrounding the umbilical area. The variable features are in the number and strength of the dorsal and peripheral bands. Taking 76 specimens, 12 were found to have the one broad peripheral band, 42 had this divided into two, 21 into three, and 1 into four smaller bands.

***Paryphanta gilliesi* (variety A) (Plate 5, Fig. 5).**

Dorsal surface similar in every respect to that of the typical species. Ventral surface the same red-brown colour but without the characteristic central dark patch. There are from four to five strong dark-brown almost black peripheral bands, three of which are situated below the periphery and are visible from the base. Other characters as in typical species.

This colour form occurs on the south side of the Paturau River and may prove to be a good geographic subspecies. There are similar specimens together with a few of the typical species in a lot reputed to have been collected on the Whakamarama Range west of Bainham. This collection however may not have been restricted to the actual locality recorded. It is not considered desirable therefore to give this form a name until more definite information is obtainable.

Habitat—Paturau River, West Coast, Nelson (Mr. Donald McKenzie, 1928); Kahurangi Point (Captain J. Bollons); Whakamarama Range, west of Bainham (per Mr. F. V. Knapp).

Two river systems, the Paturau on the west, and the Kaituna on the east, almost meet at their head-waters forming the only break in the continuity of the Whakamarama Range. This break probably acts as the segregating factor giving rise to the variation from the type observed in the form described above.

Paryphanta gilliesi subfusca n. subsp. (Plate 5, Figs. 6 and 7).

Shell moderately large, umbilicated. Dorsal surface sculptured with minute wavy spiral striae abruptly terminated at periphery. Ventral surface smooth and glossy. Colour of protoconch pale yellow, spire whorls greenish-umber toning to sienna-brown on body-whorl, variably marked with numerous narrow dark-brown and reddish-brown spiral lines, a few stronger bands at periphery and bordering the upper suture. The peripheral bands are narrow compared with the typical species and vary from two to four, the upper one being the strongest. The base is practically devoid of strong spiral colour bands and the ground colour is an olive-brown, gradually deepening to a dark greenish to reddish brown in and around the umbilicus. Axial streaks and obscure closely spaced light greenish concentric lines radiate from the umbilical patch which does not end with a sharply defined edge as in the typical species. The lowest of the peripheral bands encircles the base near to the periphery but apart from this there are no strong bands on the ventral surface. Interior of aperture and parietal wall dark-brown. Whorls slowly increasing, five, including protoconch of one and a half almost flat, slightly sunken, roughly striated whorls. Spire low, rounded, slightly raised above body-whorl. Umbilicus narrow one seventh major diameter of base. Peristome discontinuous, thin, advancing above and curved slightly downwards. Parietal callus distinctive, always covered with fine granulations, even in juvenile shells.

Major diameter 47mm.; minimum diameter 40mm.; height 25.5mm.

Major diameter 45mm.; minimum diameter 39mm.; height 24mm. (holotype).

Holotype presented to Auckland Museum.

Habitat—Kaihoka, near the coast to the north of the entrance to West Haven Inlet, Nelson, at about 120 feet above sea level. On the ground under fallen "Ponga" and "Nikau" leaves in a small patch of bush between the two lakes. Collected by Mr. A. H. Fletcher, of Collingwood.

This subspecies is separated from the typical Whakamarama *gilliesi* by the waters of West Haven Inlet and the forest area to the north of the Pakawau Gorge, from which no specimens have been seen by any of the local residents.

Dentition—Formula 64 + 1 + 64. Central tooth about same size as adjacent laterals. Individual teeth similar to those of *hochstetteri*

The permanent features of *gilliesi subfusca* apart from the granulated parietal callus, are the colour of the ventral surface

which is an olive-brown gradually deepening to a dark greenish to reddish-brown in and around the umbilicus, and the almost complete absence of spiral bands from the ventral surface. The variable features as in the typical species are in the number and strength of the dorsal and peripheral bands.

Paryphanta compta n. sp. (Plate 6, Figs. 4 and 5).

Shell moderately large, of similar size and shape to *gilliesi*. Whorls 5 including protoconch of $1\frac{1}{2}$ almost flat, roughly striated and wrinkled whorls. Dorsal surface sculptured with minute wavy spiral striae, abruptly terminated as periphery. Ventral surface smooth and glossy. Colour of protoconch pale yellow, remainder of shell golden to sienna-brown. Banding extremely variable, two to four dark-brown moderately strong spiral lines at periphery, the lowest one visible from the base; the remainder of the dorsal surface with narrow dark-brown spiral lines, varying considerably in number and arrangement. Associated with these dark lines is an obscure secondary series of light-green bands, which are practically confined to the immediate vicinity of the dark lines and vary in width according to the width of the lines they are adjoining. Mostly these green bands occur on the lower side of the dark lines. Excepting the lowest peripheral band, the base is devoid of the dark lines. There is however a gradual darkening of the colour of the base towards the umbilicus, but the darkest part is comparatively light in tone. The only other basal markings are a zone of crowded faint greenish or brownish concentric spiral lines, mostly confined to the umbilicus and surrounding area. Interior of aperture bluish-black. Parietal callus dark pinkish-grey with a few scattered granulations within, becoming obsolete towards mouth of the aperture. Umbilicus one ninth major diameter of base.

Major diameter 48mm.; minimum diameter 41mm.; height 28mm. (Holotype).

Major diameter 47mm.; minimum diameter 40mm.; height 24mm.

Holotype in Auckland Museum collection.

Habitat—Between the Castles and Beetham's Clearing at about 2,000 feet, Brown Cow Ridge, eastern side of Aorere Valley, West Nelson (A.W.B.P. and Mr. Langford, of Bainham, 23/1/1930). Living on the ground under decaying leaves around the roots of *Blechnum discolor* Forst, in mixed forest; also received from Mrs. G. Graham, Bainham.

Dentition—The correct dental formula of this species is uncertain for one of the two mounted radulae has a formula of $53 + 1 + 53$ and the other which shows abnormal features $65 + 1 + 65$. In the latter example six laterals on the extreme right and four on the extreme left differ in having several cusps and a bifid base. In most of these abnormal teeth the usual strong aculeate cusp is bifid and even traces of a third cusp are clearly shown in several of the teeth on the extreme right.

This species stands nearest to *gilliesi* and probably originated from an eastern drift of the ancestors of that species after the

uplift of the present Aorere Valley floor. The eroded sloping plateau now occupied by this species bears evidence of having been under the sea during Miocene times and having been later subjected to extensive erosion. Only a few isolated masses of the covering strata escaped destruction and so far as the writer was able to observe this species is now restricted to the forests on and in the vicinity of these areas of Miocene limestone.

The occurrence of old crushed specimens ascribed to this species in the Pleistocene and Recent silts of the valley is mentioned in the early part of this paper.

Paryphanta fallax n. sp. (Plate 6, Figs. 2 and 3).

Shell moderately large of similar size and shape to *gilliesi*. Whorls 5 including typical protoconch of $1\frac{1}{2}$ almost flat roughly striated and wrinkled whorls. Dorsal surface to periphery sculptured with minute wavy spiral striae as in other species. Colour of protoconch yellow, dorsal surface dark olive to sienna-brown, variably marked with numerous narrow spiral bands of dark greenish and reddish-brown, diffused by a secondary pattern of obscure wavy spiral lines, and frequently by spiral zones of lighter greenish and brownish tone, the whole giving a sombre dark greenish-brown to chocolate-brown appearance. The strongest of the dark-brown bands vary from three to five in number, and are situated from just above the periphery to the outer part of the base, the upper one being usually the strongest. The ground colour of the base is a dark chocolate-brown, lighter towards the outer part, just sufficient to allow the lower peripheral spirals to show. Interior of aperture dark-brown, almost black. Parietal callus dark purplish-brown, quite smooth without any traces of granulations. Umbilicus narrow, one eighth major diameter of base.

Major diameter 48mm.; minimum diameter 38mm.; height 25.5mm.

Major diameter 45mm.; minimum diameter 37mm.; height 25mm. (Holotype).

Major diameter 41mm.; minimum diameter 33mm.; height 24mm.

Holotype presented to Auckland Museum.

Habitat—Hidden Treasure Track at about 2,300 feet, Ironstone Creek watershed, between Parapara Inlet and Takaka, West Nelson (Mr. H. Ives and Mr. Flowers); on Flower's Track to Parapara Peak at about 3,000 feet, one dead shell (A.W.B.P., 25/1/1930); Onekaka Hill, on the track to the Iron Works Quarry at about 900 feet (Dr. J. Henderson, 1922).

This species is probably distributed over the Ngarino and Onekaka Ridges and extends from the Parapara River to Parapara Peak.

The shell is very similar to *gilliesi* in general appearance but can at once be distinguished by the smooth parietal callus and the chocolate, not reddish-brown colour.

The writer is very much obliged to both Messrs. Ives and Flowers, of Puramahoi, who collected the specimens upon which this species is founded.

Dentition unknown.

***Paryphanta traversi* n. sp.** (Plate 5, Figs. 1 and 2).

1913 *Paryphanta hochstetteri* var. *obscura* Suter (in part, not of Beutler, 1901). Manual N.Z. Mollusca, p. 783.

Shell moderately large, umbilicated. Dorsal surface sculptured with minute wavy spiral striae abruptly terminated at periphery. Ventral surface smooth and glossy. Colour light greenish-brown, early spire whorls and base darker. Dorsal surface with a few obscure traces of spiral bands. Ventral surface crowded with dark brown spiral bands, one or two strong ones at periphery, the remainder of varying strength becoming crowded below forming a darkened area surrounding the umbilicus. There are about twelve to fourteen spiral bands visible on the base exclusive of those merged around the umbilical area. Interior of aperture bluish-black. Parietal callus smooth, dark purplish-grey irregularly marked by axial growth periods. Whorls 5 including protoconch of $1\frac{1}{2}$ low roughly striated whorls. Umbilicus narrow, one sixth major diameter of base. Aperture lunato-oval. Peristome discontinuous, thin, advancing above and curved slightly downwards.

Major diameter 49.5mm.; minimum diameter 41.5mm.; height 28.5mm. (Holotype).

Major diameter 51.5mm.; minimum diameter 43mm.; height 32mm.

Eggs, pale olive-brown.

Length 10.5mm.; breadth 8mm.

Length 10.5mm.; breadth 8mm.

Length 10mm.; breadth 8mm.

Holotype presented to Auckland Museum.

Habitat—On the plains around Levin and Shannon, North Island; in small patches of native bush on the Government Experimental Farm, Levin, about 120 feet altitude. Living on the ground under decaying leaves (A.W.B.P., Jan., 1927); Waiopahu Reserve, on the plains near Levin (Type); living on the ground under leaves and masses of decaying "ponga" fronds in native bush (A.W.B.P., Jan., 1928).

Dentition—Formula $65 + 1 + 65$. Individual teeth similar to those of the *hochstetteri* series, except that the central tooth is considerably shorter than the adjacent laterals.

This species is confined to the plains of Pleistocene age around Levin and Shannon, in the North Island and is nearest related to *P. gilliesi*, a subspecies of which occupies the low country of early Tertiary age around Collingwood and West Haven, Nelson.

Marshall and Murdoch (1920, p. 118) suggested the former existence of a continuous beach between Kahurangi Point and

the Wanganui area during the formation of the Wanganui Upper Tertiary sediments, which are composed of material assumed to have been derived from Karamea granite. This continuous land surface would account for the emigration of a member of the *hochstetteri* series to what is now the North Island.

Probably at about the same time the areas now occupied by the Seaward Kaikoura and Rimutaka-Tararua systems were connected across Cook Strait on the eastern side, accounting for the distribution of *Wainuia urnula*, mentioned later in this paper.

WAINUIA n. gen.

Type: *Helix urnula* Pfeiffer.

The genus is a curious one showing relationships with both *Paryphanta* and *Rhytida*. It seems to stand nearer to the latter genus as shown by the malleated shell and the dentition. The radula has a relatively small number of teeth per row and the outermost lateral is only half the size of the second lateral from the margin, which is the largest; the remaining teeth diminish in size to the centre. These features are also common to *Rhytida* but not to *Paryphanta* in which a much greater number of teeth are present per row and these differ in gradually increasing in size from the margin and decreasing again towards the centre. The radula of *Wainuia* differs from that of *Rhytida* in all the teeth being long, slender and similarly shaped.

A feature showing relationship with *Paryphanta* is in the composition of the shell which is almost entirely of conchin. It has been stated by Murdoch (1906, p. 313) that the predominance of conchin in the shells of *Paryphanta* is the one prominent feature by which the shells may be distinguished from the nearly akin *Rhytida*.

The anatomy of both *W. urnula* and *W. edwardi* have been described by Murdoch (1902) and Collinge (1901) respectively. It is difficult to form accurate comparisons from these independently published descriptions but it is made quite evident that *urnula* and *edwardi* have certain characteristics of both *Rhytida* and *Paryphanta* but do not agree entirely with either genus.

The shell of *Wainuia* is characterized by being thin, black, malleated and composed almost entirely of conchin.

Probably the most interesting feature about *Wainuia* is its significant distribution, being confined to the higher levels of two big Trias-Jura mountain systems. If any further evidence is necessary in tracing the continuity of the Seaward Kaikouras of Marlborough across Cook Strait and resolving into the Rimutaka-Tararua system of Wellington, the distribution of one of the species of *Wainuia* should be taken into account.

There are only two species referable to this genus so far discovered and one, *edwardi*, is apparently confined to the Inland Kaikoura Range of the South Island and Hossack Downs, an area to the South of the Kaikoura systems, while the other, *urnula*, has been found on both the Seaward Kaikoura Range of the South and the Rimutaka-Tararua Range of the North

Island. The finding of the same species in both islands provides further evidence in support of the comparatively recent origin of Cook Strait.*

The genus *Wainuia* is never found at less than 1,000 to 1,500 feet altitude and has not been found outside the area mentioned above. The fact that the eggs are quite large eliminates any suggestion of accidental transportation.

Cockayne (Trans. N.Z. Inst., vol. 39, p. 313, 1907) and Myers (1. c., vol. 56, p. 445, 1926) have also noted in the case of plants and heteroptera respectively that "Cook Strait forms no line of demarcation."

Cotton (1916, Geol. Mag., vol. 3, pp. 248 and 319) has stated that the formation of Cook Strait probably took place subsequent to the Pliocene orogenic movements, as the result of subsidence of blocks. (See earlier part of this paper.)

KEY TO SPECIES

- (1) Shell comparatively small, major diameter 24mm. Protoconch sculptured with close, retractive axial riblets. Dental formula $14 + 1 + 14$. *urnula*
- (2) Shell larger and more globose, major diameter 34mm. Apical whorls more depressed, sculpture of protoconch almost obsolete. Body-whorl more tightly coiled. Dental formula $26 + 1 + 26$. *edwardi*

Wainuia urnula (Pfeiffer)

1855 *Helix urnula* Pfeiffer, Proc. Zool. Soc (Lond.), 49.

1913 *Paryphanta urnula* (Pfeiffer). Manual N.Z. Mollusca, p. 784, H. Suter (for full synonymy).

The following localities were given by Suter (1913, p. 785): Lowry Bay, Port Nicholson (Sir J. Hector); Crow's Nest, 4 miles north of Wellington at about 1,000 feet (R. M. Laing); Wainuiomata (G. V. Hudson); Pohui (Hutton); Tararua Mountains (H. Hamilton).

The following additional localities are known to the writer:

Paraparaumu, 2,200 feet (H. Hamilton, Oct., 1924); Wainuiomata, 1,200 feet (A.W.B.P., Jan., 1928); Mt. Holdsworth, Tararua Range (collected H. W. Simmonds, Dominion Museum coll.); Monkeyface, a mountain over 2,000 feet altitude, 15 miles due west of Kaikoura Peninsula (collected by the late Dr. J. Allan Thomson, Dominion Museum collection).

The species has previously been considered precinctive to the Tararuas and the environs of Wellington.

At Wainuiomata, *urnula* occurs quite commonly on the ground under masses of decaying "ponga" leaves. Eggs, juve-

* Since this was written Mr. Davies of the Cawthron Institute, Nelson, has sent the writer a live specimen of *edwardi*, collected on the Seaward Kaikoura Range at a point six miles north of Kaikoura and about two miles from the sea at an altitude of 500 feet. He was informed that empty shells were plentiful up to 2,000 feet. This specimen has the same dental formula as the typical species and agrees with it in every respect. The Dominion Museum specimens from Monkeyface however, although from the same range, undoubtedly have the shell features of *urnula*. It is evident that the distribution of these two species overlaps as in the case of the Marlborough subspecies of *Paryphanta*. Further field work is necessary in order to accurately define the areas of distribution of these two species.

niles and adults were collected by the writer towards the end of January, 1928.

Dimensions of Wainuiomata 1,200 feet specimens—

Major diameter 24mm.; minimum diameter 18mm.; height 17mm.

Major diameter 22mm.; minimum diameter 16mm.; height 15mm.

Major diameter 13mm.; minimum diameter 10mm.; height 9mm.

Eggs calcareous, white. Length 5mm.; breadth 4mm.

Dimensions of Paraparamu, 2,200 feet specimens—

Major diameter 24.25mm.; minimum diameter 17.75mm. height 17mm.

Eggs, Length 5.75mm.; breadth 4.4mm.

Dimensions of Monkeyface specimen (three specimens, two damaged)—

Major diameter 21mm.; minimum diameter 15.5mm.; height 14.5mm.

Dentition—Formula 14 + 1 + 14. Wainuiomata specimen (Text Fig. 2, W).

Wainuia edwardi (Suter).

1899 *Paryphanta edwardi* Suter, Pro. Malac. Soc., vol. 3, p. 290, pl. 2, Figs. 22-25.

1913 *Paryphanta edwardi* Suter, Manual N.Z. Mollusca, H. Suter, p. 780.

Type in Suter collection, now in Wanganui Museum.

Habitat—Hossack Downs, North Canterbury (E. Suter) south of the Kaikoura Ranges. Found on the hills at the source of the Hamner River, under bushes and especially under leaf mould. (Private communication from Mr. E. Suter per Mr. A. Suter, 20/12/1927); on the slopes of Tapuaenuka, Clarence River side (collected by Mr. R. Wilson, Dec., 1915; Dominion Museum collection).

Dimensions of Hossack Downs specimens—

Major diameter 30mm.; minimum diameter 25mm.; height 20mm. (Suter, 1913).

Major diameter 34mm.; minimum diameter 26mm.; height 21mm. (Topotype).

Major diameter 17.75mm.; minimum diameter 14mm.; height 13mm (Topotype).

Major diameter 12mm.; minimum diameter 9mm.; height 8.5mm. (Topotype).

Egg calcareous, white. Length 6mm.; breadth 5mm.

Dimensions of Tapuaenuka specimens—

Major diameter 21.75mm.; minimum diameter 17mm.; height 15.5mm.

Major diameter 22.5mm.; minimum diameter 17.5mm.; height 15.5mm.

Dentition—Formula 26 + 1 + 26.

Genus SCHIZOGLOSSA Hedley, 1892.

Type: *Daudebardia novoseelandica* Pfeiffer.

The genus is nearest allied to *Paryphanta*, as pointed out by Hedley (1892) and later by Murdoch (1900).

Shell auriform, flattened, incapable of containing the animal, being reduced to the function of a shield to the lungs and heart.

The radula (Text Fig. 2, S, and Fig 4, 1) consists of from 25 to 28 laterals on each side, with the outermost very small, the following four increasing in size and then decreasing to centre.

The species described below makes the second known member for the genus, which is at present known only from the North Island of New Zealand.

Schizoglossa gigantea n. sp. (Plate 1, Figs. 5 and 6).

Shell large, solid, rectangular-ovate. Protoconch with major diameter of 5mm., $1\frac{1}{2}$ very rapidly increasing whorls, first smooth, then spirally grooved as in *novoseelandica*. Post-nuclear whorl sculptured with irregular spiral striae and anastomosing axial wrinkles. The whole shell is much more massive and attains a far greater size than *novoseelandica*, and differs mainly in being flatter, more rectangular and in having the early part of the periphery distinctly keeled.

Major diameter 32mm.; minimum diameter 19mm.; height 6mm. (Holotype).

Holotype in author's collection.

Habitat—Subfossil with moa bones, cave near Tahora, Gisborne District (H. Hamilton).

PARYPHANTIDAE *

(Synopsis of New Zealand members of the family.)

Genus 1 *Rhytida* Albers, 1860. (Type: *Helix greenwoodi* Gray.)

- (1) *R. greenwoodi* (Gray). Whangaroa to Lake Guyon, Nelson.
- (2) *R. stephenensis* Powell. Stephen Island, Cook Strait.
- (3) *R. dumniae* (Gray). Kaitaia to Thames.
- (4) *R. tarangaensis* Powell. Taranga Id., Hen and Chicken Islands.
- (5) *R. duplicata* Suter. Cape Maria van Diemen and Te Reinga.
- (6) *R. meesoni* Suter. Nelson and Marlborough.
- (7) *R. patula* Hutton. Greymouth to Reefton, West Nelson.
- (8) *R. citrina* Hutton. Greymouth to Buller River, West Nelson.
- (9) *R. otagoensis* Powell. Southland.
- (10) *R. australis* Hutton. Stewart Island.

Genus 2 *Paryphanta* Albers 1850. (Type: *Nanina busbyi* Gray.)

- (1) *P. busbyi* (Gray). North Auckland Peninsula.
- (2) *P. hochstetteri* (Pfeiffer). Pīkīrūna-Tasman and Haupiri Ranges, West Nelson.
- (3) *P. hochstetteri obscura* Beutler. Western Marlborough Sounds.
- (4) *P. hochstetteri bicolor* Powell. Eastern Marlborough Sounds.
- (5) *P. superba* Powell. Eastern side Aorere Valley and Rocks Point, West Nelson.
- (6) *P. lignaria* Hutton. Karamea to Mokihinui River, West Nelson.
- (7) *P. unicolorata* Powell. Mokihinui River to Westport, West Nelson.

* The family name is here changed from *Rhytididae* to *Paryphantidae* in conformity with the now generally accepted method of basing the family name on the oldest genus name admitted to the family.

- (8) *P. rossiana* Powell. Mount Greenland, Ross, Westland.
 (9) *P. gilliesi* Smith. Northern Whakamarama Range, West Nelson.
 (10) *P. gilliesi* (var. A.) Southern Whakamarama Range, West Nelson.
 (11) *P. gilliesi subfusca* Powell. North side West Haven, West Nelson.
 (12) *P. compta* Powell. Eastern side Aorere Valley, West Nelson.
 (13) *P. fallax* Powell. Ngarino and Onekaka Ridges, West Nelson.
 (14) *P. traversi* Powell. Levin, North Island.

- Genus 3 *Wainuia* Powell, 1930. (Type: *Helix urnula* Pfeiffer.)
 (1) *W. urnula* (Pfeiffer). Rimutaka-Tararua Ranges, North Island and Seaward Kaikoura Range, South Island.
 (2) *W. edwardi* (Suter.) Inland Kaikoura Range and Hossack Downs, South Island.

- Genus 4 *Schizoglossa* Hedley, 1902. (Type: *Daudebardia novoseelandica* Pfeiffer.)
 (1) *S. novoseelandica* (Pfeiffer). North Island.
 (2) *S. gigantea* Powell. Cave near Tahora, Gisborne (sub-fossil).

- Genus 5 *Delos* Hutton, 1904. (Type *Zonites coresia* Gray.)
 (1) *D. coresia* (Gray). North Island.
 (2) *D. jeffreysiana* (Pfeiffer). North Island.

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DESCRIPTION OF PLATES.

PLATE 1.

- Fig. 1. *Paryphanta hochstetteri* (Pfeiffer) (Plesiotype).
 Fig. 2. *Paryphanta hochstetteri* (Pfeiffer), Canaan, Nelson.

Figs. 3 and 4. *Schizoglossa novoseelandica* Pfeiffer, Manaia, Whangarei Heads.

Figs. 5 and 6. *Schizoglossa gigantea* n. sp. (Holotype).

PLATE 2.

Figs. 1 and 2. *Paryphanta hochstetteri obscura* Beutler (Topotype).

Figs. 3 and 4. *Paryphanta hochstetteri bicolor* n. subsp. (Holotype).

PLATE 3.

Paryphanta superba n. sp. Rocks Point specimens.

Wm. C. Davies, Cawthron Institute, Photo.

PLATE 4.

Fig. 1. *Paryphanta lignaria* Hutton, Mokihinui.

Fig. 2. *Paryphanta unicolorata* n. sp. (Holotype).

Fig. 3. *Paryphanta superba* n. sp. (Holotype).

Figs. 4, 5 and 6. *Paryphanta rossiana* n. sp. (Holotype).

Fig. 7. *Rhytida greenwoodi* (Gray), Muriwai, West Coast.

Fig. 8. *Rhytida stephenensis* n. sp. (Holotype).

PLATE 5.

Figs. 1 and 2. *Paryphanta traversi* n. sp. (Holotype).

Figs. 3 and 4. *Paryphanta gilliesi* Smith (Plesiotype).

Fig. 5. *Paryphanta gilliesi* (var. A.) Paturau River, West Nelson.

Figs. 6 and 7. *Paryphanta gilliesi subfusca* n. subsp. (Holotype).

PLATE 6.

Fig. 1. *Paryphanta gilliesi* Smith (Plesiotype).

Figs. 2 and 3. *Paryphanta fallax* n. sp. (Holotype).

Figs. 4 and 5. *Paryphanta compta* n. sp. (Holotype).

Fig. 6. *Paryphanta unicolorata* n. sp. (Holotype).

PLATE 7.

Paryphanta hochstetteri obscura Beutler. Specimens from the "Old Mōkatapu Track," 2,952 feet, East Nelson Mountains.

Wm. C. Davies, Cawthron Institute, Photo.

Fig. 1. HYPOTHETICAL GEOLOGICAL MAP OF THE COOK STRAIT REGION, ILLUSTRATING THE DISTRIBUTION OF PARYPHANTA AND WAINUIA.

(Based partly on Morgan's 1922 Geological Sketch Maps of N.Z.)

Fig. 2. GENERIC TYPES OF DENTITION IN PARYPHANTIDAE.

S. *Schizoglossa* (Type), R. *Rhytida* (Type), W. *Wainuia* (Type), P. *Paryphanta* (*hochstetteri*), D. *Delos* (Type).

Fig. 3. RHYTIDA.

1 and 2 *Rhytida greenwoodi* (Gray), Muriwai, West Coast.

3 and 4 *Rhytida stephenensis* n. sp., Holotype.

5 *Rhytida dunniæ* (Gray), Whangarei.

6 *Rhytida tarangaensis* n. sp. Holotype.

7, 8, 9 *Rhytida patula* Hutton, Mokihinui.

10, 11, 12 *Rhytida otagoensis* n. sp. Holotype.

Fig. 4. DENTITION OF SCHIZOGLOSSA AND RHYTIDA.

1 *Schizoglossa novoseelandica* Pfeiffer.

2 *Rhytida dunniæ* (Gray).

3 *Rhytida tarangaensis* n. sp.

4 *Rhytida stephenensis* n. sp.

5 *Rhytida greenwoodi* (Gray).

6 *Rhytida otagoensis* n. sp.

Fig. 6. DENTITION OF PARYPHANTA.

A. *P. atramentaria* Shuttleworth, Victoria.

M. *P. milligani* Pfeiffer (= *fumosa*), Tasmania.

B. *P. busbyi* Gray, North Auckland, N.Z.

H. *P. hochstetteri* Pfeiffer, Nelson-Marlborough, N.Z.

L. *P. lignaria* Hutton, West Nelson, N.Z.

S. *P. superba* n. sp., West Nelson, N.Z.

G. *P. gilliesi* Smith, West Nelson, N.Z.

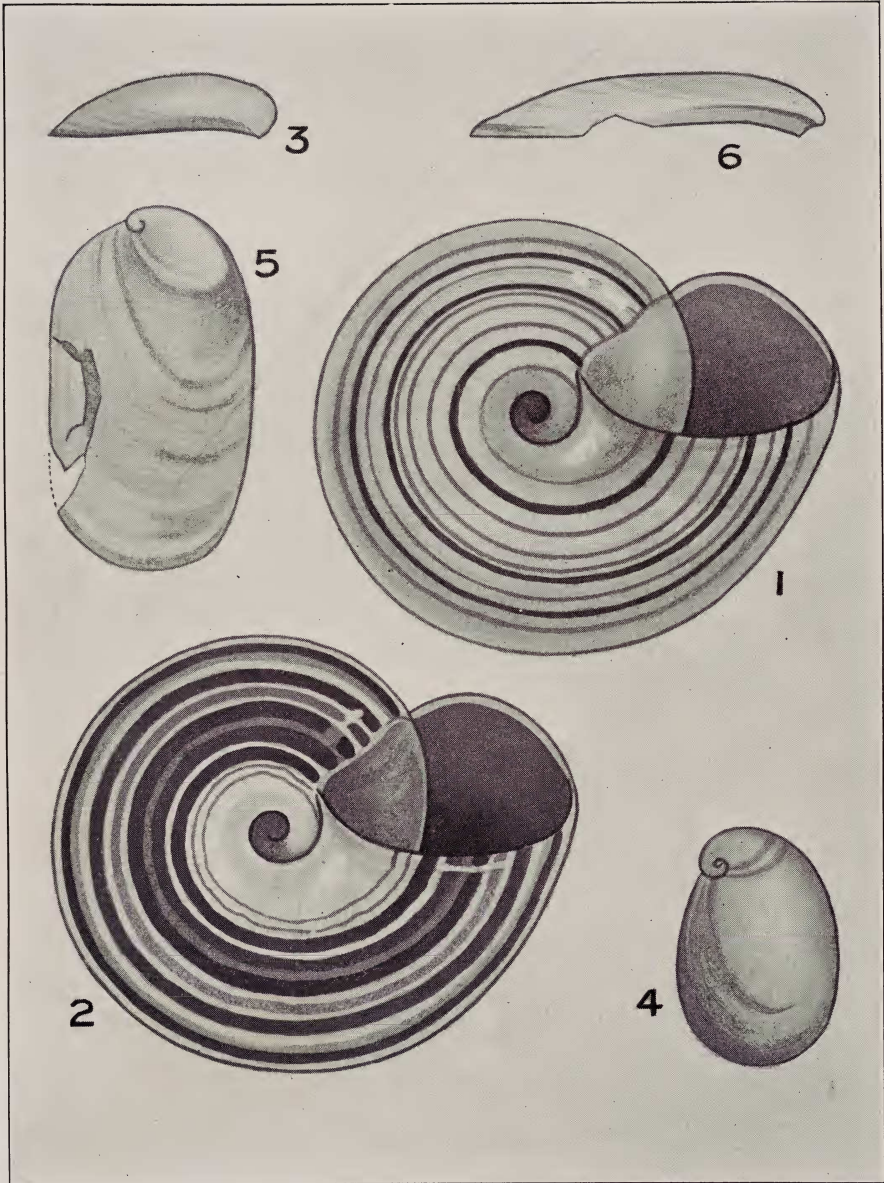
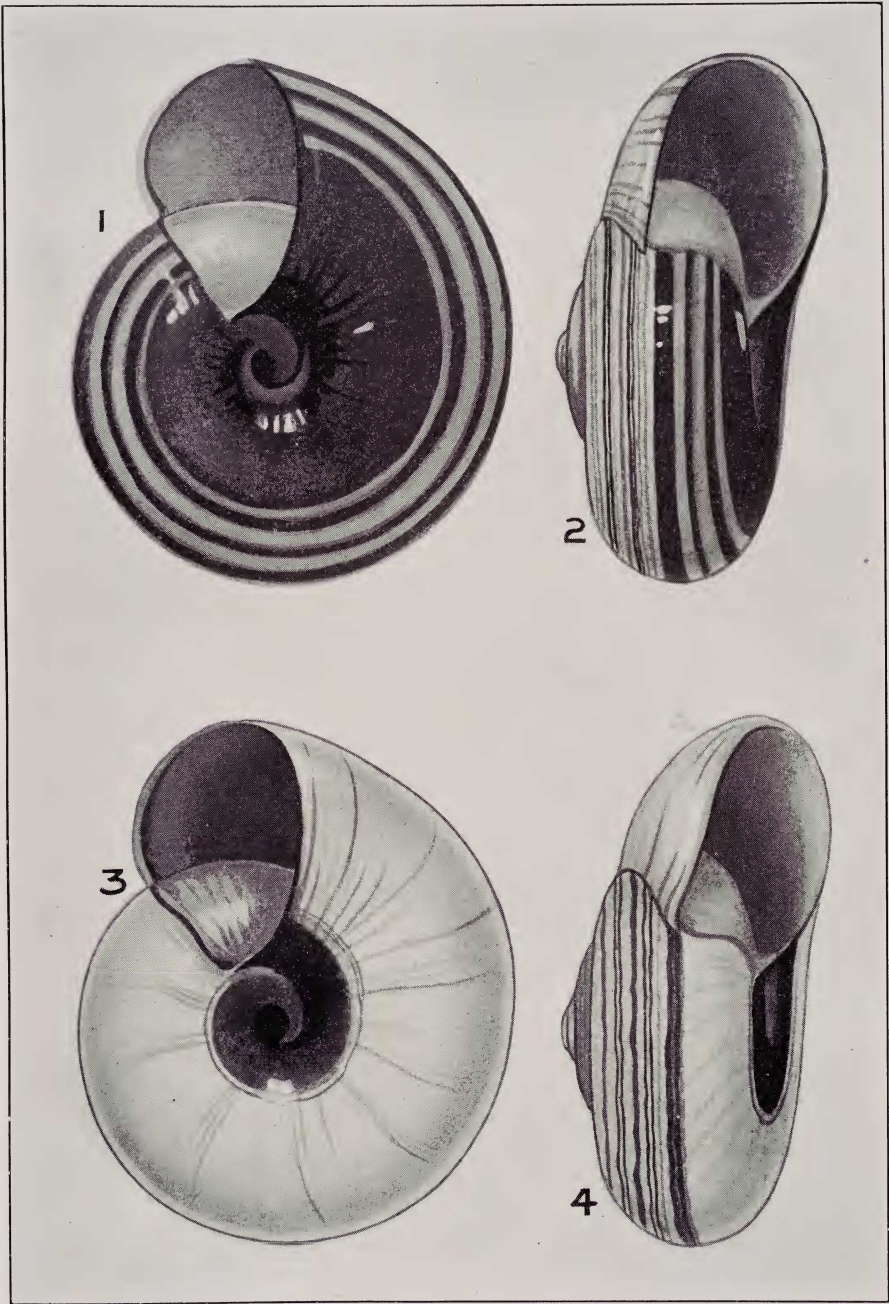
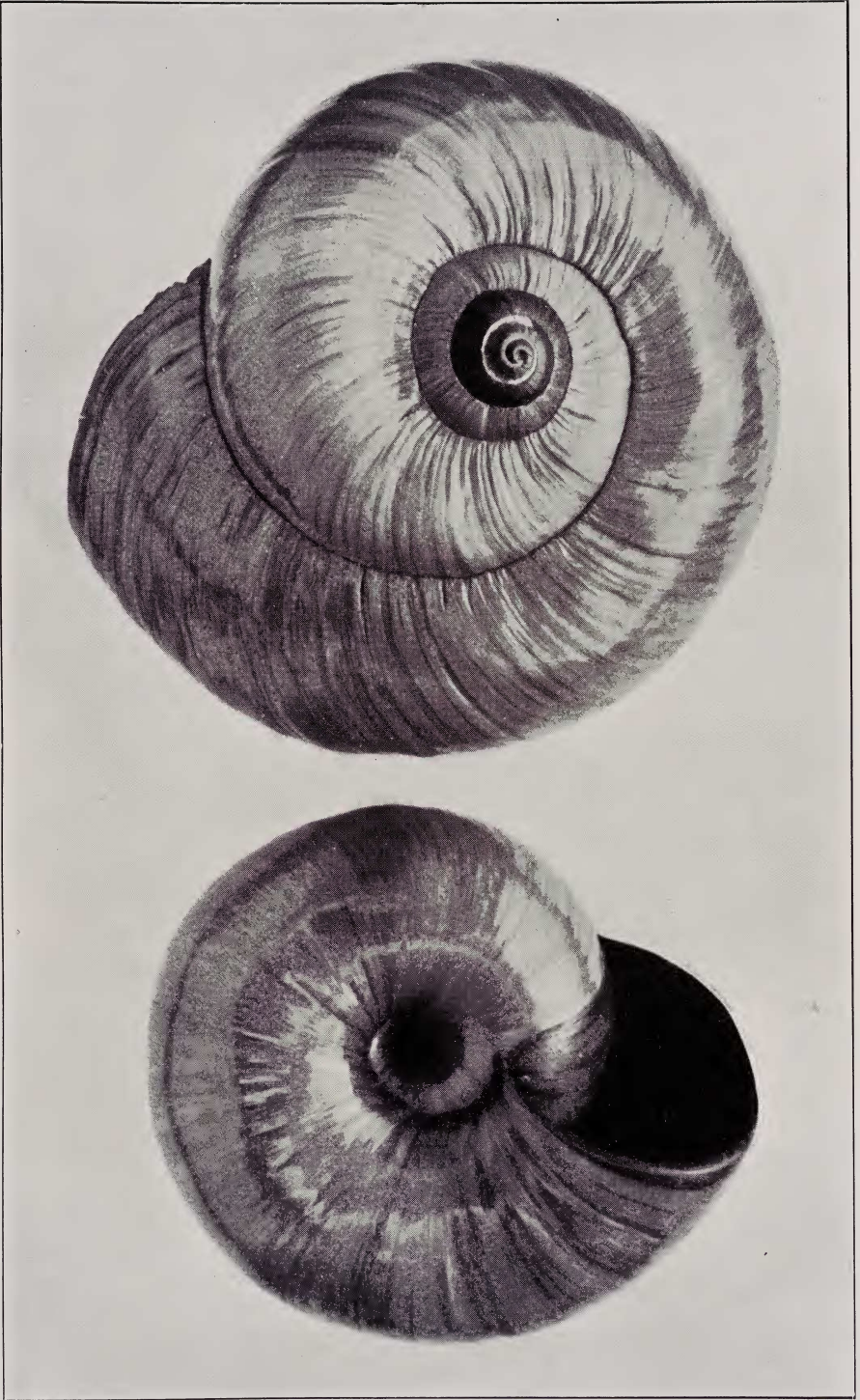


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Figs. 1 and 2. *Paryphanta hochstetteri obscura* Beutler (Topotype).
 Figs. 3 and 4. *Paryphanta hochstetteri bicolor* n. subsp. (Holotype).



Paryphanta superba n. sp. Rocks Point specimens.
Wm. C. Davies, Cawthron Institute, Photo.

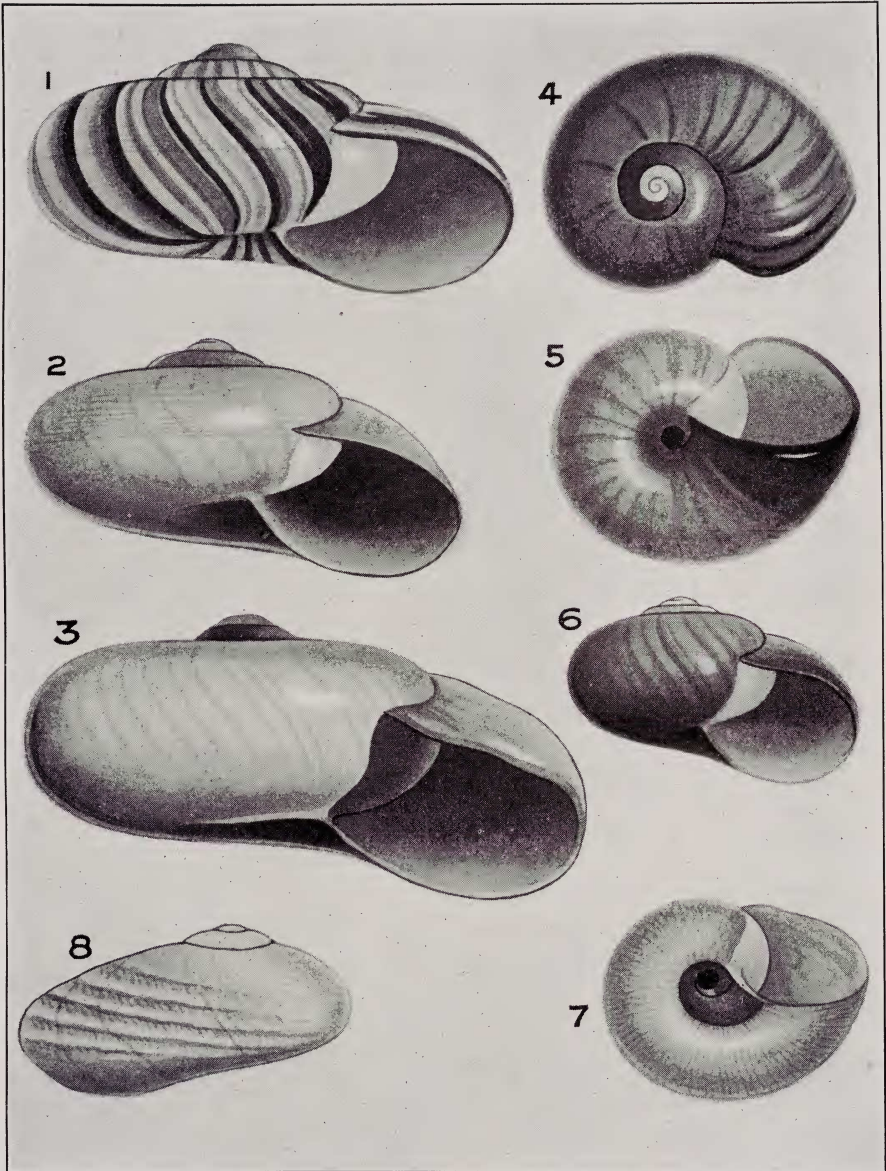
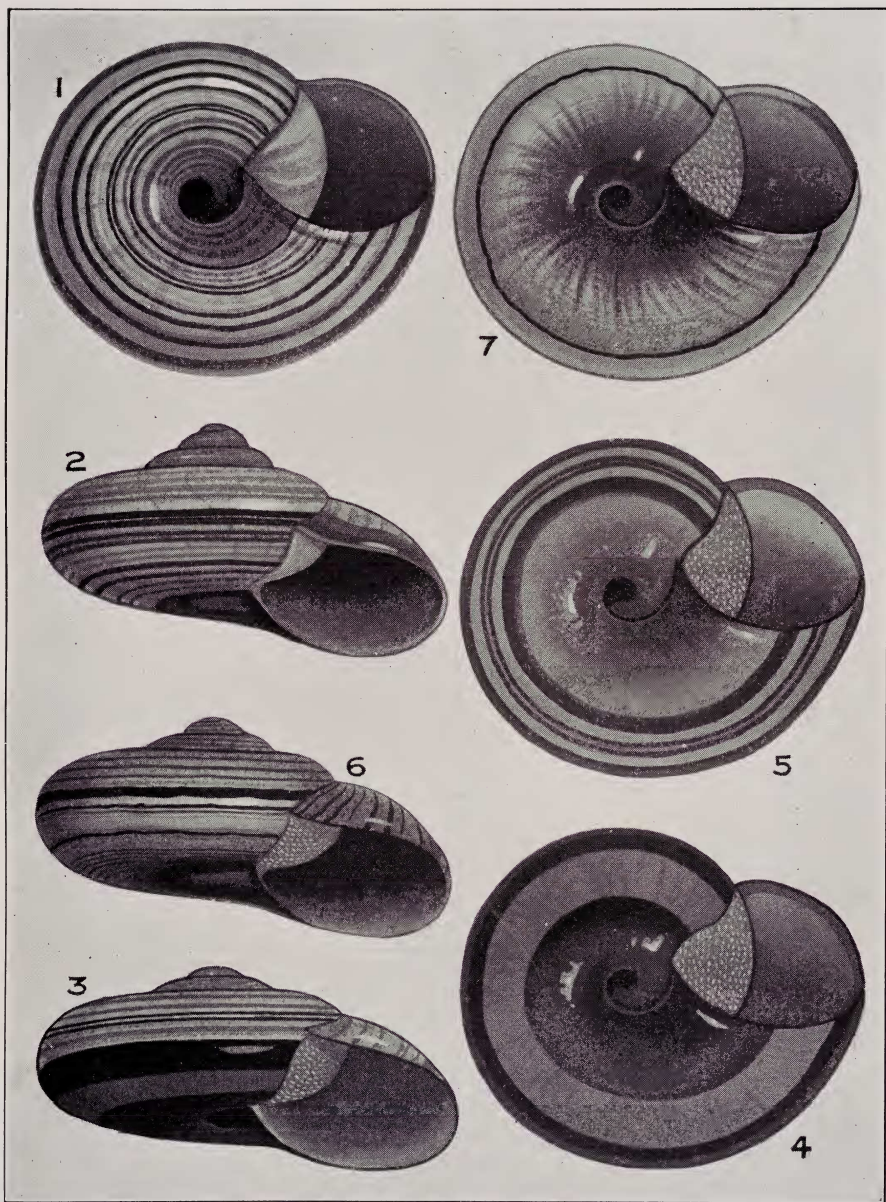


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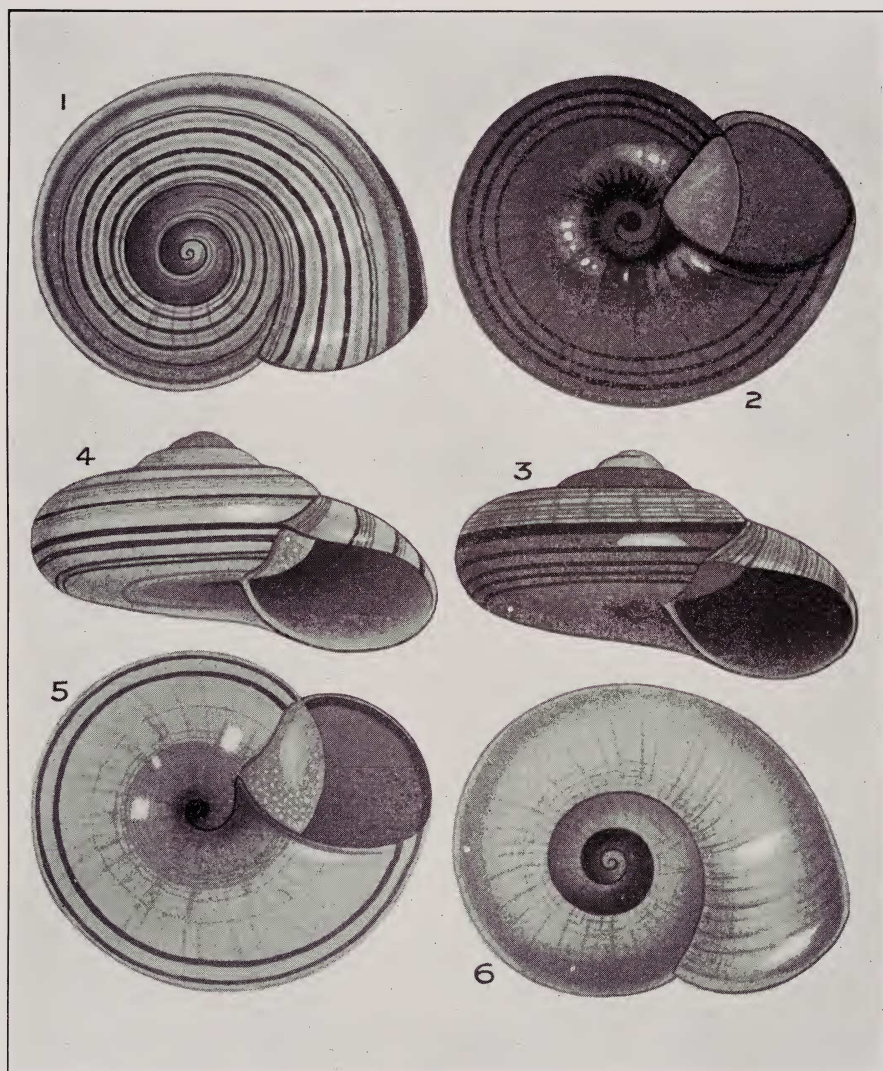
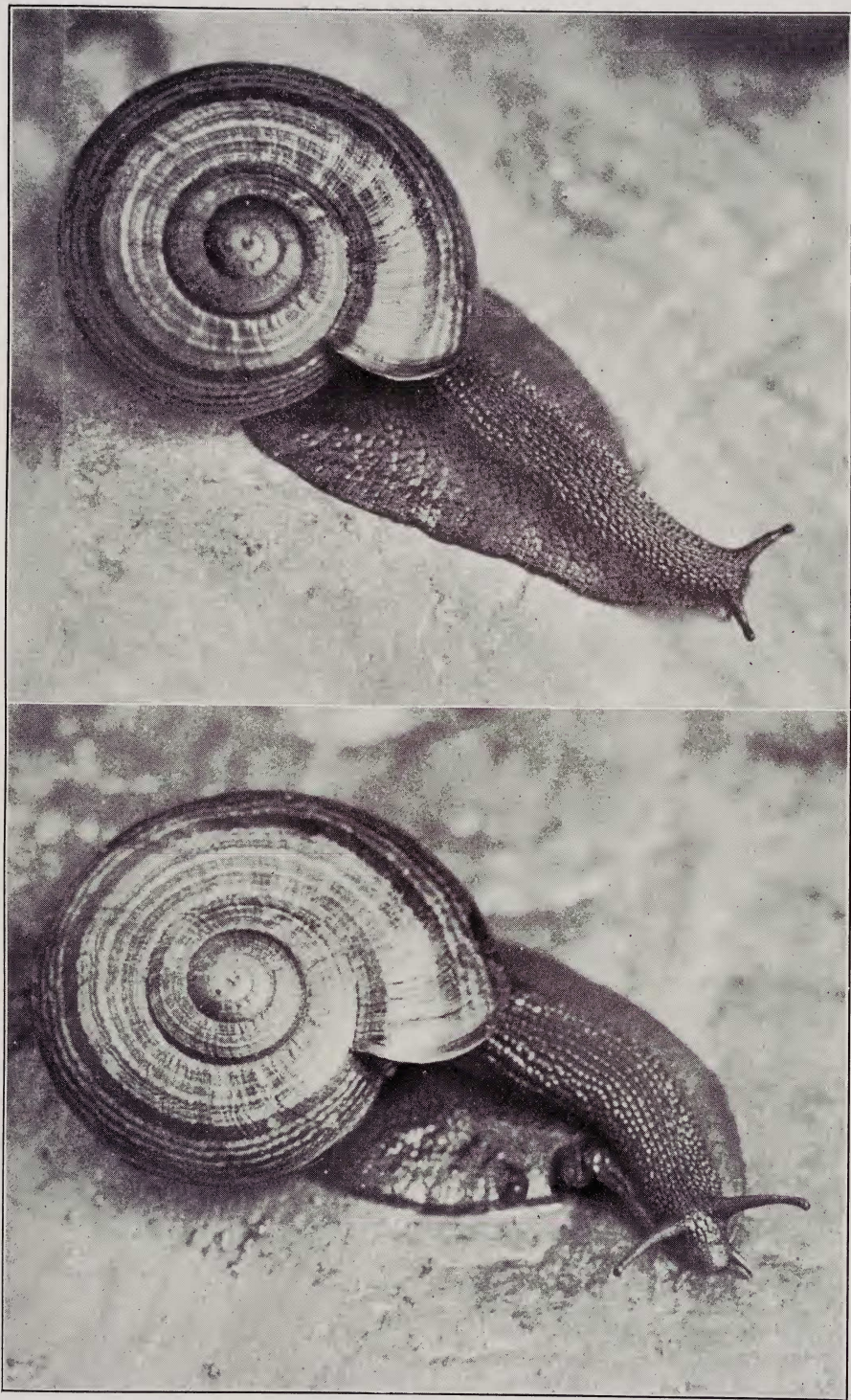


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Paryphanta hochstetteri obscura Beutler. Specimens from the "Old Moka-tapu Track," 2,952 feet, East Nelson Mountains.
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